A CONSULTANT'S VIEW ON AIR RECIRCULATION

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Abstract

The viewpoint of industry over the past years has been influenced by State and local government regulations restricting recirculation to nuisance dusts. This is probably the present viewpoint as industry is not aware, for the most part, of the newer, less restrictive approach.

Industry is interested in recirculation from the standpoint of fuel saving and because of concern of possible restriction on fuel use, which would restrict operations and future expansions.

Worker contaminant exposures determined by theoretical models will not be satisfactory as determined on the basis of approaching Threshold Limit Values.

Industry needs help on how to apply recirculation to specific processes and operations, other than listings of design factors. The design factors, however, are needed.

My original assignment was to discuss "An Industrial View on Air Recirculation." When I looked at the program just before coming out here, I found that the title had been changed to "A Consultant's View on Air Recirculation." However, I will stay with my original assignment for most of my discussion and add at the end some discussion on a consultant's viewpoint.

In considering the industrial view on recirculation, I would like to go back over the years and review the type of thinking with which some of us influenced industry.

My first experience with industry was a number of years ago when I first got out of school. I was hired by a mining company with mining operations--primary and secondary crushing plants--to do something about the dust; they apparently had discovered that they had a great many silicosis cases. I designed local exhaust dust control systems, such as they were, for the crushing, conveying, and screening equipment. I remember wondering if I should dare to put effective dust control equipment on the exhaust of the primary crusher. Well, I didn't. Instead, I used a cyclone collector. Makeup air and heating replacement air were not thought of by management, not that it

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wasn't cold enough (this was in the Adirondack mountains of New York) and I knew enough not to suggest it if I wanted to keep my job. However, interestingly enough, we did have one recirculation job--mining dust.

Mining dust exposure is very heavy from dry drilling hard rock. A shift was made to wet drilling, but that wasn't exactly pleasant. Miners often came out cold, wet, and muddy. Some relatives of the mine manager conceived the idea of using an air ejector and exhausting air around the drill bit with a little exhaust hood called a "Kelly Trap." The dust-laden air went into a cyclone collector which, in turn, discharged the exhaust air into the mine. Recirculation took place because it was hardly practical to discharge air 4,000 ft below ground to the outdoors.

My next job was with a very active governmental industrial hygiene bureau. During my period of work there, two events occurred that influenced the thinking of industry. One was the writing and publishing of the Industrial Ventilation Manual (ref. 1), the other was the start of the Michigan Industrial Ventilation Conference. I remember my experience as an instructor at the early conferences. Most of us were learning with our students. Sometime during the early conferences, "makeup" air became a popular phrase, and we pounded it into the students. Most places had no replacement air, and we found that it also cost money to heat air. Industry began taking on the problem with us and makeup air entered into their plans. It was slow. Even today there are very few places that have enough replacement air.

During the 32 years that I was with the government bureau, a few recirculation units came into use. Several unit collectors appeared with fans and dust collectors. These were of small capacity and were used for nuisance dust grinding operations, tool grinding, jewelry grinding, and dental appliance grinding. A little later, some large units of the wet collector type appeared in the auto industry. These were up to 15,000 ft^3/min capacity. Oil mist collectors of the electrostatic type also appeared. A number of these were set up for convenience as recirculation collectors. This concerned us, as we felt that oil mist was more than a nuisance material. There was some inference of it causing lipoid pneumonia, which later appeared to be unfounded. A plating tank mist scrubber appeared that was tried on some acid pickling baths. Although the discharge concentration did not exceed the threshold limit value, something irritating the discharge caused us to turn it down. Finally, as I recall, a pharmaceutical company presented a plan for recirculation of certain pharmaceutical dusts. The system was well-designed and had an efficient fabric collector. After much consideration, it was decided, as a matter of policy, to not allow the recirculation of toxic contaminants and regulations were formulated regarding recirculation. At about the same time, several other governmental agencies were also setting up regulations. Finally, the Industrial Ventilation Manual published guidelines. I do not want to take credit for what appeared in early editions of the Industrial Ventilation Manual, as it reflected the opinions of several government agencies as well as our regulations. The pertinent part reads as follows:

> Recirculation Not Recommended: It is the general policy of all official health agencies not to recommend recirculation of exhaust air if the contaminant is a material which may have a definite effect on the health of the worker. The reasons are as follows:

1. Many types of air cleaners do not collect toxic contaminants efficiently enough to remove the health hazard.
2. Poor maintenance of the air cleaner would result in deliberate return of the highly contaminated air to the breathing zone of workers . . .

Recirculation accepted some types of air contaminants, particularly dusts regarded as nuisances rather than true health hazards. For exhaust systems handling these materials, recirculation may be accepted. No blanket acceptances can be made . . . . (ref. 1)

Inasmuch as the Industrial Ventilation Manual has worldwide acceptance as an authority and is also used as a text at the Michigan Industrial Ventilation Conference and a number of similar conferences, I believe the above policy has wide coverage and has influenced the thinking of industry over the years to accept the position that only nuisance contaminants can be recirculated. In my experience with the governmental health agency, several acceptable proposals for recirculation were made and turned down. One was a recovery unit for perchlorethylene used in dry cleaning. A test on the emissions showed a low concentration. I think it could easily have been made fail-safe, but due to the agency's regulation, it was flatly turned down. I think this policy has affected the industrial viewpoint to accept, in most cases without murmuring, a regulation to limit recirculation.

At the moment, most industrial personnel are not aware of the fact that a new look has been taken at recirculation and that it is being considered on a wider basis. I believe the 1974, 13th edition of the Industrial Ventilation Manual was the first edition to suggest that recirculation can be permitted for other than nuisance materials. There has been some repercussion to this, but not a great deal. It appears that a great many persons do not read the fine print in this book and are not aware of this change. To help industry, there may be a need to approach Federal, State, and local agencies in such a way that they will be open-minded in considering recirculation.

As consultant to the contract group developing criteria for the recirculation of industrial exhaust air, I had the opportunity to call several industries to determine if they were willing to assist the group in allowing them to look at processes and exhaust ventilation systems in view of considering such operations for recirculation. With one exception, the industries contacted were willing to cooperate and also were willing to allow field measurements and air determinations. In a number of cases, but not all, certain industries would even allow a private research group to enter their premises.

Some of the larger industries have energy conservation departments. Others are working directly with plant engineering departments in their energy conservation efforts.

Some of the reasons for the consideration of recirculation by these groups are as follows:

1. With escalating fuel and power costs, there is a need to reduce the high cost of air conditioning and heating large volumes of makeup air. As one representative of an energy conservation department

stated, "When I look at all the air we are exhausting, this looks like the place to begin to save energy." It is not unusual in the auto industry to exhaust over one million ft^3/min in one building.

2. A fear or concern that fuel (gas or oil) will be restricted. As one plant engineer stated, "We believe we can get the same quota of gas that we got this year for next year. We are not sure if this quota can be increased. We intend to put in new heat treatment furnaces that will require more fuel and we believe we can obtain additional fuel to do this through recirculation."

Normally, if recirculation is applied to an existing exhaust system and no hood design changes are made, it is expected that the worker's exposure level will increase. How much increase can we allow? It sometimes appears attractive to persons making theoretical considerations to allow up to the Threshold Limit Value (TLV). I do not believe industry, in most cases, can work with this. I know of plants with both welding fume exposures and grinding dust exposures where the measured exposure values are only a small fraction of the TLV. Management in both cases is afraid to reduce airflows to save energy because they feel labor troubles will result. Certain existing levels of exposure cannot be increased without a challenge from labor.

If industry is to be given guidelines and assistance in recirculation of air, there is a need for more than a listing of contaminants that can be recirculated, a cataloging of various types of air cleaners, a summary of design features of monitoring equipment, and a model for recirculation. All this information is useful and basic, but more practical working information is needed. The approach that appears most practical is the preparation of workable methods of design for specific operations or processes such as plating, welding, woodworking, grinding, etc. An example of this, in another field, is the Air Pollution Engineering Manual (ref. 2), put out by a government agency. Presented in its guidelines are practical methods of control applied in some detail to specific processes and industries.

The following request I recently received from industry illustrates the practical information needed:

> Prepare a study to determine the technical and economic feasibility of recirculating welding fumes. The study shall include:
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> 1. analysis of the air contaminants encountered,
> 2. recommendations of continuous air-monitoring equipment,
> 3. recommendations of the appropriate air-cleaning devices,
> 4. cost- and energy-saving estimates for each system, and
> 5. preparation of a design guide for a prototype system that proves to be most economically feasible,

There is currently a need for information on specific monitoring of alert alarm systems for recirculation. There is a need for factual information on efficiencies of air cleaning equipment as applied to specific operational contaminants. If we are presenting to management models for recirculation based on efficiencies of collectors and fail-safe alert alarm monitors and controls, there is a need for equipment manufacturers to furnish this material. Finally, the recirculation design models must be applied to existing

control systems now operating with outdoor discharge to prove that such systems are workable and economically feasible.

The economic feasibility is a factor that industry will probably consider very carefully. Currently, the cost of recirculation systems of fail-safe design is high. Monitoring, alert control equipment is high in cost and possibly will be until simplified production equipment is available. In systems where, due to lack of space, the air cleaning equipment is placed out of doors a distance from the process, heat losses occur and high static pressures in the system require high power inputs into the fan motor. When these factors are balanced against heating cost savings in makeup air, there may be very little advantage.

I have up to this point, attempted to present considerations that enter into the industrial viewpoint from my own experience. Since the final title of this paper has been changed to "A Consultant's View on Air Recirculation," I feel obligated to add a few comments on what might be a consultant's view.

Since current recirculation practices may involve material that could have adverse health effects rather than just nuisance considerations, I believe consultants, especially those with some industrial hygiene experience, will tend to "play it safe." For example, if lead fumes were the contaminant, and if an electrostatic precipitator with several passes of high efficiency were used, I would back it with high-efficiency filtration. Electrostatics do lose efficiency through insulator failure and when they do, unsafe concentrations may discharge. Using a different concept of cleaning such as filtration, which apart from filter breaks increases in efficiency with use, may give an additional measure of safety in addition to the monitor safeguard.

A consultant will need to consider not only one contaminant but contamination from all processes and operations. For example, in recirculation of welding fumes by means of suitable air cleaning devices there will be a trend to save energy by reducing makeup air. When this is done, certain operations, such as the operations of propane-fueled lift trucks, need to be considered. In this instance, if insufficient dilution air is not provided, an unsafe carbon monoxide exposure will result.

As a consultant, I intend to avoid using monitoring devices that require a constant laboratory service although there will be many of these devices proposed. Most industries do not have full-time personnel available to service technical instruments. For one monitoring operation, I have selected an instrument used by an air pollution bureau for several years which requires very little maintenance service.

Certain economic factors will need to be considered. If the contaminant is collected wet and there are no plant wet waste treatment facilities, the cost for air cleaning will be high. If high static pressure collectors are used, the electric power costs will be high and this will need to be compared with heat savings costs. Equipment that requires maintenance with shutdown periods may not be economically feasible. There will be a need to calculate maintenance labor costs to determine actual savings.

Although I was not here yesterday, I am familiar with the criteria development material presented by John Hagopian and Scott Stricoff of A. D. Little, Inc. I have looked over their model and believe it can be applied practically to simple exhaust and makeup air systems. On large, complex systems with multiple exhaust and makeup systems, I would have difficulty applying model equations and feeling confident that I was getting the right answer. For example, I am currently working on a building with a large floor area and a volume of 187,000,000 ft^3, with 35 separate exhaust systems and 38 makeup units distributed throughout the building, and supplying about 2 million ft^3/min. We are starting with a few exhaust systems and converting them to recirculation systems and possibly we will reduce the makeup correspondingly. It seems to me that to predict the breathing zone steady-state condition (if it is reached), there may be a need to consider local exhaust and makeup air in certain small areas rather than the plant as a whole. There is undoubtedly a need for further studies on recirculation involving actual plant conditions before and after recirculation. The work by A. D. Little, Inc., appears to be a valuable start for such a study.

REFERENCES

1. Industrial Ventilation Manual, 11th edition, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, P.O. Box 16153, Lansing, Michigan, 1951, pp. 5-7.

2. U.S. Department of Health, Education, and Welfare, Air Pollution Engineering Manual, Public Health Service, National Center for Air Pollution Control, Cincinnati, Ohio, 1967.

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FOREWORD

These proceedings of the symposium on "The Recirculation of Industrial Exhaust Air" are submitted under Contract No. 210-77-0056 to the National Institute for Occupational Safety and Health of the U.S. Department of Health, Education, and Welfare. The symposium was held in Cincinnati, Ohio, on 6-7 October 1977.

The objective of this symposium was to discuss the development of technical criteria for the recirculation of industrial exhaust air. With emphasis on the protection of the worker's health, technical subject matter discussed included: (1) decision logic for determining recirculation feasibility; (2) design and performance guidelines for recirculation systems; (3) availability of air cleaning and monitoring systems; and (4) maintenance guidelines.

Mr. Robert T. Hughes, Chemical Agents Control Section, Control Technology Research Branch, Division of Physical Sciences and Engineering, National Institute for Occupational Safety and Health, Cincinnati, Ohio, was the Symposium General Chairman.

Mr. Alfred A. Amendola, Control Technology Research Branch, Division of Physical Sciences and Engineering, National Institute for Occupational Safety and Health, Cincinnati, Ohio, was the Symposium Vice-Chairman and Project Officer.

Mr. Franklin A. Ayer, Manager, Technology and Resource Management Department, Center for Technology Applications, Research Triangle Institute, Research Triangle Park, North Carolina, was the Symposium Coordinator and Compiler of the proceedings.