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DIGEST OF DISCUSSION AT ROUND-TABLE ENGINEERING CONFERENCE

on

DUST CONTROL AND INDUSTRIAL VENTILATION

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1. Air Conditioning of Crane Cabs
2. Keeping Dust Exhaust Systems Clean
3. Cold Drafts in Work Areas
4. Air Volume Requirements for Exhaust Hoods
5. Air Sterilization in Industry
6. Dust Collectors and Air Cleaning

Attendance and Contributors: Plant Engineers of Industrial Hygiene Foundation Member Companies

Mellon Institute, Pittsburgh

November 13, 1945

Industrial Hygiene Foundation.....4400 Fifth Avenue.....Pittsburgh, Pa.

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NOTE TO MEMBER COMPANY ENGINEERS:

The control of industrial processes and operations for the elimination of occupational hazards and for the improvement of working conditions is primarily an engineering problem. Such problems frequently confront the Plant Engineer and he solves them regularly — largely without the benefit of any published data or reference material. Too frequently the solution comes only through trial and error. This wealth of experience possessed by Plant Engineers is not widely employed owing to the lack of any means of collecting and distributing it. Thus, a particular plant is forced to find its own solution, when, in another establishment the problem may have been solved already.

The purpose of the Engineering Conference of the Industrial Hygiene Foundation is to provide a needed medium for exchanging experience among Plant Engineers for the mutual benefit of all. The first Conference was held on November 13, one day before the Annual Meeting of the Foundation. It was attended by 74 Plant Engineers from 55 Member Companies. The Conference was in the form of an informal round-table discussion which gave opportunity for all to take part — in contributing experiences or in raising questions for discussion. The accompanying Digest of the meeting does not attempt to cover the technical proceedings but rather to indicate the nature and scope of the Conference. The need for such a Conference is evidenced by the lively interest throughout the meeting and the universal desire of those attending to continue the Conference on an informal round-table basis. Plant Engineers in Member Companies are invited to make the Conference a year-round vehicle for exchanging data and asking questions. Address communications to Mr. Theodore F. Hatch or Mr. W.C.L. Hemeon, the Foundation's engineers.

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Managing Director

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I. AIR CONDITIONING FOR CRANE CABS

Alertness and efficiency of crane operators are essential to production and safety. In certain industries, especially those with excesses of heat, fumes and gases, crane operators may require special protection. The air-conditioned crane cab has been developed for this purpose.

One type described at the Conference consisted of an enclosed cab, 94 cu. ft. in volume, with safety glass panels for maximum vision and with all metal surfaces insulated (2" rock wool). The refrigerating equipment is built as a unit, 27" x 33" x 6' high, and removable for major repairs, 95% accessible for routine service. The air-cooled compressor and cooling fan are operated by 1-1/2-2 HP motor. The capacity of the unit is 150 c.f.m. with 40 c.f.m. outside air and remainder recirculated. The cooling capacity is sufficient to maintain the cab temperature at 85°-90°F., with an outside temperature up to 140°F. Experience indicated that 300 c.f.m. total capacity would be prefered to 150 c.f.m. Air enters the cab through a slot around the top and is withdrawn at the floor. The air is cleaned through an oiled surface filter and vapors are removed by activated carbon canisters.

A simpler cooling unit, applicable particularly to dry climates, employs an evaporative cooler of the capillary cell type, 8" deep. Air is cooled to within 5°F. of outside wet bulb temperature. The unit carries its own water supply of 40 gal., sufficient for eight hours operation. The evaporative cooling unit is considerably cheaper than the mechanical refrigerator but is limited to use in relatively dry atmospheres and plants in which moisture is not added to the plant air.

New cabs, designed for maximum operator convenience (one has controls mounted on arms of seat), were quickly installed over the week-end. This cab

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includes platforms for easy entrance, for servicing refrigerating units and for window cleaning which was required daily. Plastic windows, tried in place of safety glass, scratched in about six months.

In another industry, recirculation was found undesirable and the total capacity of 200 c.f.m. is taken from outside — this was sufficient for a cab of 200 cu. ft. volume. The initial design provided for 70-80% recirculation but operators complained of becoming drowsy. Cab temperature was controllable by the operator and commonly kept in the low 70's. In other plants where there are no heat problems, conditioning units for dust removal only, have been employed with a capacity of 2000 c.f.m. for large cranes of 60-100 tons. Cleaning is accomplished by filtration through wool bags at a rate of 6 f.p.m.

The cost of the equipment was given approximately as follows:

New cab ready for installation	$2700
Conditioning unit	up to $2000-$2500

It was pointed out that the cost was very much less than for a new roof ventilating system to improve working conditions for the crane operator.

II. KEEPING EXHAUST SYSTEMS CLEAN

Dust exhaust systems can be designed and operated without troublesome deposition of collected dust in the pipes. Why, therefore, is this so frequently a source of trouble?

Air velocity in pipes in general should be 3000-4000 f.p.m., but higher velocity may be required for certain materials. Almost never should velocities go lower than 3000 f.p.m., as a basis of design (but lower velocities down to 1500 f.p.m., have worked for special cases). The lowest possible velocity consistent with maintaining clean pipes is desirable, however, to secure a maximum balancing of the system.

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Air volume maintained. An enclosed process may require a high ventilation rate and correspondingly large pipe when the enclosure is opened for servicing or inspection and greatly reduced volume when closed. During the latter period the low pipe velocity leads to dust settlement. This can be corrected by providing a weighted damper on a bleeder opening into the branch pipe which is actuated by the negative pressure within the system. The damper opens when the hood doors are shut and the extra air drawn in through the bleeder maintains the desired pipe velocity.

Exhaust system "built", not designed. Too many exhaust systems are built without proper aerodynamic design to insure balance of flow and pipe velocities. To illustrate, consider two branch pipes of the same length and common take-off from the main pipe, one 12" and the other 4" in diameter. The larger pipe will have velocity greater than desired and the smaller a lower velocity. An adjustable damper in the large pipe will correct the flow but is undesirable because it will get out of adjustment and is subject to wear with abrasive dusts. Such conditions of unbalanced flow should be avoided in the initial layout and design. It was pointed out further, that even with good initial design, the shop manager may add extra exhaust branches without consulting the central engineering office, this should not be permitted.

Unit collector at process. A favored means of avoiding dust settlement in pipes is to install a collector close to each process (especially those requiring long branch pipes.)

Condensation of moisture and sublimation as gases cool in the exhaust branch were discussed. In one plant dusty air exhausted at 500° and carrying moisture cooled in the pipe with condensation and dust deposition. Insulation of the pipe prevented condensation and corrected the situation. Condensation

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causes dust settlement even at high velocities. This may also be true with fine dusts containing no coarse particles. In the latter case, very high velocities may aggravate clogging.

Velocity to remove settled dust. Once dust has settled and compacted a greater velocity is required to pick it up again than to maintain it in suspension. Hence, a dust deposit tends to cause more deposition. Comparable to this, the practice of pounding the pipe to clear out settled dust distorts the pipe and the irregularities then encourage new dust deposits.

Design of hood connection. Abrupt hood connections may pick up needlessly large material from the process with subsequent settlement in the pipe. Low velocity entrance into the exhaust branch has corrected this condition in many cases. In answer to the question "What to do about it?" the following were considered:

Balanced design. The initial design must be worked out to give the best possible balance and proper air velocities — this involves layout (avoid long branches), selection of proper branch and trunk sizes in relation to air volumes to be handled from each process.

Compressed air nozzles are sometimes installed at intervals (every 8' in one reported case) within the system as a remedy. The high velocity jets dislodge and resuspend the dust for removal. This is an expedient which should not be confused with basic preventive measures in design.

Cleanouts properly placed for straight-through access, and accessible for use, are desired.

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III. COLD DRAFTS

Drafts of cold air along the floor are a cause of complaint, particularly troublesome during the war as a result of greater congestion of plant populations and greater numbers of women workers. What is the major cause of such drafts and how can they be prevented? It was agreed that a common cause is the failure to provide for a controlled air supply into the plant to make up for that exhausted. In one extreme case, a tile wall collapsed because of the negative pressure exerted by the exhaust system. Provisions should be made to supply the make-up air through properly located intakes and, with large exhaust systems, the air may require heating. Attention was called to the economy of natural gas surface heaters which may be installed directly in the air supply system. Experience indicates that with proper burner design, no CO hazard exists. Several engineers reported excellent results with this method.

Opening of large shipping doors is a frequent cause of trouble. Workmen will not bother to use entrance vestibule doors. A large propeller fan directed outward toward the door may help. Blast Heaters are sometime employed over doors to produce heated air curtains. In some cases these are operated automatically when the door is opened.

In one plant, despite heating of the make-up air, conditions were not comfortable because of "drafts". Humidification of the make-up air reduced evaporative cooling of workers and complaints ceased.

It was pointed out that perhaps twice the volume of exhausted air may be required to insure a positive pressure within the building. To obviate this, one plant has enclosed processes from which a large air volume (50,000 c.f.m.) is exhausted in a room within the plant and heated air is drawn directly into this room.

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IV. HOW MUCH AIR IS REQUIRED FOR CONTROL OF PROCESS?

Is there a fundamental basis for determining the volume of air to be exhausted for dust control? An approach to this question is to consider the cause of dust escaping from a process. The dust does not escape of its own accord — it is carried away by air which, in many processes, is displaced by the process itself. Clearly, the exhaust hood must draw off an amount of air in excess of that displaced by the process. As an example, rock falling from a belt into a hopper or bin acts like a fan, drawing air into the rock stream and discharging it when the rock strikes the next surface and piles up. A grinding wheel acts as a fan; a hammer mill, similarly, produces considerable air flow. Practical means of measuring the air displacement in rock crushing operations were described. These formed the basis for the actual design of exhaust systems for one establishment. Definite, measured air flow requirements rather than the usual estimates were used to determine capacity. The application of this same approach to the problems of other industrial processes was discussed.

V. AIR STERILIZATION

(1) Are factories, in general, an important source of air-borne infection compared with other places workmen inhabit, as theatres, trolley cars and buses?

(a) It was felt that there is reason for doubt on this point where for process reasons there is a high rate of ventilation in the workroom, or workers are stationed at a distance from each other in the plant. Research that includes measurements of air-borne bacterial concentrations in various types of factories should be carried out to ascertain whether there is an advantage in sterilizing the air of the plant.

(2) If some types of plants were found to be a significant source of cross-infection, would air treatment be worthwhile so long as trolleys and buses, theatres and the like operated in the absence of air sterilization?

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(3) Since it has been shown that air-borne dust is a serious obstacle to the effective action of germicidal agents, will it be practical to realize any benefits in industries that produce dust, even though the amounts of dust are small and they are not classed as dusty industries?

(4) Since sterilization is not very effective where the relative humidity is excessively low or high (it should not be lower than 25 to 50% for best results), what difficulties in application to industry would be expected on that score?

(a) Most industrial plants are poorly adapted to the maintenance of relative humidities as high as 25% in very cold weather due to poor heat insulation of walls and roofs and of windows.

(5) Since air sterilization is simply a method of reducing the concentration of air-borne organisms, and whereas both an increase in mechanical ventilation and recirculation of plant air through dust filters might be expected to produce similar results, what would be the relative cost of each method in various types of plants?

The practice of air sterilization in occupied places is still in the experimental stage. The foregoing questions which developed during the discussion need to be answered before the practical value of air sterilization in industry can be appraised.

VI. DUST COLLECTORS AND AIR CLEANING

Since each problem of air cleaning presents its own requirements, there was little in the nature of general requirements to consider. The first question raised was: What is the permissible rate of discharge of dust from an industrial stack? Can meaningful values be set up for different kinds of dusts and for neighborhoods of various classes? Based upon such "standards", can prospective purchasers of equipment specify their requirements in terms of

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dust collector efficiency in relation to particle size? In clear-cut cases, such as control of sulphur dioxide fumes, this is regularly done. For miscellaneous industrial dusts the situation is less clear. It was pointed out that the art of air cleaning is constantly advancing and, in general, keeping abreast of the demands with respect to air pollution. The efficiency of the selected dust collector should be the highest available within reasonable economic limits.

The problem of large volume air cleaning (hot) for suppression of nuisance dust and fumes is one of major economic importance. What methods are available for such situations at reasonable cost and without excessive size of air cleaning plant? The application of techniques of metallurgical fume collection to such problems are considered. Use of high stacks, as commonly practiced for SO_2 disposal, was proposed for consideration. The value of meteorological studies and advice in regard to plant location and method disposal was also pointed out. One type of wet collector for cleaning of hot, corrosive gases was described. Acid-proof lining of the chamber and the use of external sprays have given long life with minimum servicing in the collection of highly acid wastes.

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