Theater Engineering Conference

Ventilating and Air Conditioning

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Note: For the Theater Engineering Session on Ventilating and Air Conditioning, Chairman Seider requested that all discussion be held until after the delivery of the last paper in the group. The material which follows, therefore, is in the nature of a panel discussion and deals with all four papers in this particular section.

Discussion

Mr. Hubert: Mr. Kimball spoke about return diffusion wells in cooling systems to get rid of the water. At Lowell we found out that when we returned the water to the ground, depending, of course, upon the volume of water and the size of the return well, the well is effective for a period of about six months. Then it will take no more water.

The pump man surges it with acid and it commences to take water perfectly again. It lasts for three months this time. The next acid treatment lasts for about six weeks. About the fourth time, it is effective for about a day.

Is there any way that you have had success in returning water to the well? The reason we are interested in it is because the city has imposed a sewer charge on us; in other words, if you put water into your theater, then they charge you 50 per cent of your water bill as a sewer charge. In the case where you are using well water, they meter the well and if you use 600 gallons a minute, they figure up what the cost would be. If you brought that water from the city, they charge you that much for a sewer charge.

If we can return that water to the ground, we would save ourselves a great deal of money, but so far we have not been able to do it. Is there any way that you can assure a successful operation of these return wells over a period of time?

Mr. Dwight D. Kimball: You must be in a district where you have a peculiar subsoil condition. There is in New York State a limited area, largely around Long Island, where the State Conservation Commission requires return of water. I have had return diffusion wells that have been used for years without such trouble. Once in a great while you get a condition where you have to surge a well, but it stands up for quite some time after that.

I do not know what your problem could be, but you certainly must be in a strict area where you get these charges, because you can drill all the wells you want to, if you get permission of the State Conservation Commission and abide by their rules, but you do not pay any water rate.

Mr. Hubert: As I understand it, the City spent about $150,000 in one year on municipal sewers. Under this new arrangement, they are going to collect about $2,500,000 a year on the water charge.

However, our wells there are gravel wells. In most cases, the gravel is a mixture of anywhere from half an inch up to about two inches in diameter. The reason they started these return wells is that during the war the rubber companies, and similar plants, used an immense amount of water. They were using about 75,000,000 gallons a day in the war industries. Naturally, the recovery is about

50,000,000 gallons a day. So they made them put the water in the ground, because they could not keep the water table up; but they ran into trouble on the wells and the wells would not take it.

We were formerly using 800 gallons a minute in our cooling system, when it was a street-water job. We have now installed refrigeration, and we have four theaters there. Two hundred a minute is the smallest and about 450 is the largest.

MR. W. B. COTT: We found in our experience, particularly in our own plant, that if you alternate the use of waste wells, you will prevent the silting up of the gravel there. Louisville has a very low water table. There is a range of hills back of Louisville that lowers the water table; and as you get down to the flat of the river, alternate the use of the wells. As an example, we are drilling one well to put the water in now. Another well to put the water, in fifty to sixty days, helps considerably there. The wells have not been silting up so fast as they have been in the past.

It might be well for you to examine the possibility, with your well contractor, of drilling additional wells for their disposal; that is, alternate the use of wells, one in this period of time and the other in the next period of time.

MR. HUBERT: We have never tried that. The Deal Pump and Supply Company near Louisville used to drill quite a few of those wells, and now they have given up the idea of drilling return wells for the people, because everything has been tried to keep them from liming up, but they always do, except for a short-term operation where you want to use it for six months, then it is all right and they will drill a return well. However, if you have the idea of using it over a period of time, it is a waste of money. The liming process takes place over quite a large area, and forms a large cone there. When you surge it, you just push this liming process away from the well. Then it limes up to the well again. When you treat it again, it pushes it farther. Eventually, it gets so limed up that you cannot push it out, and that is why the well quits altogether.

If you drill two or three wells and alternate them as you suggest, would not that be a case of prolonging the process until your wells lime up again?

MR. COTT: I do not think so. The various whiskey distilleries there return their condenser water and the processed water to alternate wells.

MR. PHELAN: Mr. Kimball, I was impressed by your costs on filters, but, in mentioning a throwaway-type filter costing $500, that is only the initial cost.

MR. KIMBALL: Yes.

MR. PHELAN: Do you not think that we should consider what they will cost over a period of time in comparison to the electric filter, where the operating cost only amounts to what an electric light bulb would use?

MR. KIMBALL: The difficulty is that most theater people want to make their investment returnable in matters of replacing material on a basis of something like four to six years, and you do not come out even on that basis. If you can do it over a longer period of years, you have a saving in favor of the electrical. However, they look too much not alone on this, but on their investment costs.

MR. PHELAN: When you enter into the cleaning costs, the drapery costs, and so forth, I think that that would pull down the over-all cost on them, too.

MR. KIMBALL: It is pretty hard to get a theater man to take that into account. I venture to say here in the Times Square district, you can go to theater after theater and most of them have not been redecorated since they were built.

MR. ROBERT LEWIS: Dr. Buttolph, I have been using ultraviolet disinfecting lamps for some time. I have observed two factors. First, the reflectors on these lamps, apparently, by virtue of their being pointed upward, act as sort of a catch-all for dead bugs, silting, and other things. Second, apparently, there is a degeneration of the glass envelope, either by bombardment at the end or by a general glass degeneration.

I am well aware that you are required to have decent reflector performance, but the thing which struck us as peculiar was that it appeared to us after a period of not more than a day or so, that these small dusty positions on the reflectors appeared fluorescent. We wondered if you have any figures on that type of problem and efficiency, and, second, what is the average life you should expect from glass envelopes.

DR. L. J. BUTTOLPH: The germicidal lamps themselves depreciate very rapidly the first few hours and the first day of operation. As a matter of fact, they are officially rated after 100 hours of operation, to offset that to some extent. After that, they depreciate about the way fluorescent lamps do.

The problem of collection of dirt on the reflectors is exactly the problem you have with lighting fixtures. If the installation has been engineered with an adequate factor of safety, that is not too serious a matter, however; but it is important that you originally specify two or three times as much germicidal ultraviolet as is really necessary, just to take care of those variations.

MR. LEWIS: Perhaps I did not make the question quite so precise as I should. It was our observation that the effectiveness of the reflector was zero after a day.

DR. BUTTOLPH: No, it is not that bad. We have measured many of them. The ordinary dust that settles on the reflector acts as a neutral filter between the particles. You can get dust absorption up to 25 or 50 per cent, but your installation should take care of that. Again, it is the same problem that you have with an installation for illumination.

MR. LEWIS: I believe that ultraviolet of that wavelength is not the same problem as illumination. Otherwise, I think it is an answer.

MR. ALBERT STETSON: Mr. Cott commented on the fact that the cost of service had been accelerated upward. He said that it was now running from 23 to 27 cents. I believe he means 23 to 27 cents per seat per year.

MR. COTT: That is correct.

MR. M. D. KICZALES: Mr. Cott mentioned the use of ammonia refrigerant in air-conditioning systems. I am curious to know what states permit the use of ammonia in air-conditioning systems.

MR. COTT: There are quite a few ammonia systems installed; in fact, I can take you within seven blocks of the hotel you are in, and show you four.

MR. KIMBALL: In places of public assembly?

MR. COTT: Yes, sir, in old equipment. They are carefully trapped and they are carefully watched by the City of New York. There are several theater installations using ammonia in Chicago and several in New Orleans. However, we have been trying to sell those people replacement equipment in the past. It may amaze you to know that there are six installations within the city limits of Manhattan, using methyl chloride, which is highly poisonous and highly dangerous. As a matter of fact, it is equipment that we as a manufacturer have a responsibility for now, because we purchased the company that made the methyl chloride.

MR. KICZALES: We agree that present codes in practically all states of the Union do not permit the use of ammonia.

MR. COTT: That is true on new installations, but there are existing installations using those poisonous refrigerants. Under the new codes the use of ammonia refrigerants is not permitted.

MR. KICZALES: Mr. Kimball, this afternoon we had quite a session on acoustics and the prevention of noise in the systems. Particularly, some recommendations were made to prevent the transmission of noise from air-conditioning equipment. One of the speakers recommended certain limitations in the design of air-conditioning systems primarily, saying that the air-supply ducts should be set at 500 feet per minute, and the recirculating grill should be set at 250 feet per minute, in order to be safe and remain within the 35-decibel allowance for the theater.

MR. KIMBALL: Those are, economically or from an engineering standpoint, rather absurd limits, because I do not know of any jobs installed with those very low velocities. If you take a large 1000-seat theater, particularly under the present rate, we could not get space in the building in many cases. However, I have used 1200, in some cases 1400 feet, for years without trouble; that is, in the main larger ducts. You get smaller ducts, of course, but we have no trouble if the duct work is substantially designed and built.

MR. KICZALES: I made a recommendation like that this afternoon, and it seemed that certain architects and engineers did not hold to that stand, when I mentioned that we were using 1200- to 1400-foot velocity starting at the fan, and reducing as we go along down to the outlet. It went as far as 600 feet per minute at the outlet itself, and we wanted to design 400 to 450 at the recirculating grills.

Mr. Kimball mentioned extending the air-supply duct into the lobbies in order to prevent a back draft from the opening of doors into the theater. I have very successfully made use of a concealed unit heater with a recirculating grill at the bottom, and filtering the air across the lobby entrance with proper controls at the ceiling and at the floor to give a proper temperature. That would heat the air before it moved down the lobby into the rear of the theater.

MR. KIMBALL: That is perfectly possible, but it lacks one advantage. If you install it as I suggest, you not only get heat in the winter, but you get air conditioning into the lobby in the summer.

MR. KICZALES: With the air-conditioning system in the summer time, you can do with a lower air temperature in the lobby as it usually, passsing through, is more or less a cooling-off chamber to prepare you for the lower temperature in the theater proper. We use more or less the exhaust system from the lobby and pass it on through; I mean, from the auditorium to the theater and then on out. That is the air you have to throw away normally.

MR. KIMBALL: In the case of ultraviolet treatment, where in the theater would you place your lamp to meet the approval of the architect? Second, what would be the approximate cost of such a treatment, say, in a 1000-seat theater?

DR. BUTTOLPH: In the old theaters, it is almost impossible to find any place that would satisfy even the architect who designed it, to say nothing of the modern ones. Fortunately, the modern theater designs are rather adaptable. We have one or two installations where they are perfectly adaptable. They are horizontal wall treatments into which fixtures can be recessed, to be practically unnoticeable.

The installation cost runs about $1.00 per seat. The lamp replacement cost is

about 10 cents per seat. That cost does not include the maintenance, which can be thrown in with the maintenance of the illumination of the place, because there is just the matter of dusting up whenever they clean up the theater.

MR. KIMBALL: I have had two occasions within the last two years of giving the theater a designed air-conditioning system, and the architect gave me the pronouncement that there should be no opening outlets in the ceiling or walls. If he will not permit air outlets, how will he allow those light outlets?

DR. BUTTOLPH: That light outlet is a horizontal slot only about 6 or 7 inches high, at the most, and 3 feet long per unit. So it is not too conspicuous. It should be broken up by horizontal black louvers, and thereby mask the reflectors. So, it can be designed into a new place rather easily.

MR. KIMBALL: The great problem in a theater is this: In a filled auditorium, you do not like sitting next to somebody who is coughing violently and sneezing. Will that ultraviolet treatment take care of such a condition?

DR. BUTTOLPH: No, particularly not the psychology of that particular situation. Glycol will handle that particular job, at least the psychology of it. I do not know whether it works fast enough to catch the drop in its foot of travel.

MR. J. W. SPISELMAN: Dr. Robertson and his associates have recently published a paper in which they actually, by advanced methods of collecting air samples, have tested the exact killing rate. What they found was that the kill was so rapid within the first second that they could take their first air sample and see that at least 80 to 85 per cent of the kill had been completed. That is within the first second of the injection of droplets simulating that of a sneeze or a cough. Within the second second, another 50 per cent of the remaining 15 per cent will be killed. At the end of the third second, they were down to virtually a zero count as far as the bacteria injected into the chamber was concerned.

Other evidence, such as the direct spray into hospital wards, which I had mentioned before, and into cages with mice and into other guinea-pig tests, has indicated that the glycol reaction is an extremely rapid one.

I might point out that glycol has been used for years as a dehumidifying agent in massive absorbers; in other words, in much the same way that lithium chloride is used, the same way that silica jel is used. Triethylene glycol has been used as a chemical humectant, in a dehumidifying agent.

In some installations, air flowing at the rate of 500 feet per minute over a distance of only some 2 feet, we can almost calculate how rapidly it is dehumidified. Air has been dehumidified from, let us say, 60 to 70 per cent humidity down to 25, indicating a very rapid absorption of water.

Conversely, the argument is that at that same rate of speed a moist particle will pick up glycol, indicating that the actual pickup of glycol must be an extremely rapid affair; and once the concentration has been formed on the bacterial particle, death will take place.

MR. KIMBALL: How quickly?

MR. SPISELMAN: As quickly as medical men have been able to pick up an air sample. In this one particular piece of work, they feel that they picked it up within one half of one second, which is the first one that they want. At that time there was between 75 and 80 per cent of kill; in other words, they had that much less than they had sprayed in. I have heard that when ultraviolet kills germs, it will kill them just as quickly.

DR. BUTTOLPH: We think that the sneeze has been entirely overrated as a spreader of disease. The probability that an adjacent person actually will be able to inhale any considerable number of organisms from a particular sneeze is surprisingly remote. The rate of diffusion even in a foot or two, is rapid. In general, the inhalation is not so timed with the sneeze as to gather much of the contamination. It is largely a psychological problem.

MR. KIMBALL: I was going to say you have a psychological problem, and you have confirmed it.

MR. KICZALES: The American Society of Heating and Ventilating Engineers has always felt that the determination as to what germs are really effective and detrimental in air-conditioning systems, was up to the medical profession itself and not up to mechanical engineers. I believe at the last meeting held about a year ago at Cleveland, there were some talks presented about the use of germ-killing means in air-conditioning systems, and no definite conclusion was reached as to whether they were needed or not, even in large air-conditioning systems.

However, in my opinion, since we are talking about theaters in this particular meeting, where you are being exposed to germs for about two hours, I doubt whether there is any need for any germ-killing means in an air-conditioning system in a theater. From my small knowledge of the medical profession and germs, we find that there are germs in the air, but they are not all disease germs; that they will not attack the body. You can put a glass of water or a little globule of water under a microscope and you will find it crawling with germs, but it is still considered pure water. They do not kill. They do not cause disease. I wonder how many germs there are in an air-conditioning system that do spread disease; whether it is economically sound to put in some kind of germ-killing apparatus.

DR. BUTTOLPH: The Society of Heating and Ventilating Engineers, through one of its committees on air disinfection and the Research Laboratory in Cleveland, is working on some research projects for the Society itself. It recognizes bacteria as one of the real contaminants of air, along with body odor and dust. There is no question about the recognition. Both the Society of Bacteriologists and the American Medical Association recognize that there is a problem. The Council of the American Medical Association has a setup by which it examines equipment for air disinfection. That does not happen to be on air ducts, but it does read on the need for air disinfection.

MR. SPISELMAN: It has been part of the work that I have done, although I am an engineer. I have set out dishes and I have collected some of these plates that show the amount of bacteria and germs that are in the air. I was interested in it, very much the same along the lines that your were, and I had a few medical men, bacteriologists, examine the plates. I was really amazed at the number of pathogens that will fly around in the air.

I have asked the same question: Just why doesn't it affect all of us? Quite often, the answer is that there is a certain threshold level to which you can withstand the bacteria and the pathogens. Beyond that threshold level, which is determined by the concentration of those bacteria in the air, they start working on the various people, on some more than on others.

Moreover, in a recent issue of *Science Newsletter*, I read that the cold virus is particularly bad in that one respect: By the time you know you have gotten the cold, it has been in your body for a long time and has incubated. As a matter of fact,

they are trying to determine the rate at which a person does pick up a cold, if he is susceptible to it, and they have it down to within minutes once they have been exposed to it. That is about all I can say in reference to your question.

MR. KICZALES: Has the medical profession ever stated that the air-conditioning systems in theaters do cause disease? Have they come out point-blank and stated that they should be provided with some germ-killing apparatus? No one has yet determined that some disease is caught in a theater.

We cannot be too sure whether anyone caught the cold after he left the theater, whether the contact was made in a streetcar coming home, or on the street, or in the theater. I believe the purpose of the research being done by the American Society of Heating Engineers is to determine that. True, it is a project, but no definite determinations have been made by the committee as to what was needed.

MR. SPISELMAN: I do not know whether any public health outfit has come out and said flatly that the theaters are a hotbed of disease or anything of that nature, but time and again I have picked up papers during epidemic periods, and one of the first places that you are warned to stay away from are theaters and places of public congregation. That of itself, coming out from individual public-health servants, quite probably shows what they must have in the back of their minds as to where the probable focal points of any disease or any epidemic may start. The same thing is applied to swimming pools and to other places of public congregation. By and large, they do not leave out the moving picture houses or the theaters. They usually see to it that those are included in the statements.

MR. KICZALES: Someone should combat these statements by the public officials; that a theater owner should put in some sort of system just to advertise that he has some sterilizing equipment in his air-conditioning system.

MR. NEIL WHITE: Mr. Kimball, in the average air-conditioning installation in a theater, what is the period over which a complete air recirculation takes place?

MR. KIMBALL: It will vary to a certain extent with the density of the seating and the height of the theater; in other words, the cubic feet of space per person. However, they run around seven changes an hour on an average.

MR. WHITE: I have had a little experience with one unit of this ultraviolet lamp. I seemed to detect a change in odor in the room, and as though there had been ozone generated or some ionization had taken place.

DR. BUTTOLPH: All germicidal lamps, at least if they are built so that they are effective at all, produce minute amounts of ozone. It is a manufacturer's problem to prevent their producing too much. There is probably some odor masking due to the ozone. Other than that, germicidal ultraviolet is a remarkable photocatalyst; that is, ordinary oxidation by oxygen goes on much more rapidly in the presence of germicidal ultraviolet. Probably both those things are effective. Practically, I believe there is no effective installation of germicidal lamps where there is not a noticeable change in odor.

Recently, a number of companies started promoting the lamps purely for that purpose. They are entirely comparable with these recently advertised chemical substances for that purpose. We have chosen not to feature that, because we think that is a minor job the lamps can do in the long run. It is incidental to their more important use for air disinfection.