MINISTRY OF PUBLIC INSTRUCTION

HYGIENE IN PRIMARY SCHOOLS

AND

NURSERY SCHOOLS

OVERALL REPORT

BY

DR. JAVAL

PARIS

NATIONAL PRINTING

M DCCC LXXXIV

This document was produced by nousaerons.fr working group from the original text available at https://gallica.bnf.fr/ark:/12148/bpt6k6477721v

Paragraph naming (in blue below) was added by the editors to allow better orientation in the text.

Machine translation by Google.

Contents

III. Aeration, ventilation and heating

Introduction

We must bluntly admit our inability to lay down, in terms of ventilation, rules applicable to all particular cases. The means to be used to renew the air in heavily populated premises are not formulated with precision in hygiene treatises, and it is enough to set foot in any meeting room to see the inexperience of architects in this respect. . After a laborious study, the 4th Sub-Commission found that great practical progress had been made quite recently in England and especially in America, but it could not find any author in which guiding principles were clearly set forth. It follows that, in our desire to proceed logically, we have had to take it upon ourselves to make a theoretical exposition drawn from our own resources: this is said to excuse the extent that we have allowed this part of our work to take.

Reminders on ventilation and heating

Everyone knows that the air is quickly stale by breathing and that staying in a confined atmosphere is harmful to health. In addition, the contamination of the air by the emanations of living beings has the effect of producing a cerebral state incompatible with sustained attention and which can manifest itself in an almost irresistible drowsiness.

When the temperature is the same outside and in the meeting room, it is easy to obtain a sufficient air exchange by opening the windows, if the noises from outside are not an obstacle. This process, the best of all when it is permitted to employ it, presents serious inconveniences during strong heat, insurmountable during cold.

The Commission was unable to form a sufficiently certain opinion to lay down rules relating to summer ventilation.

As for winter ventilation, the first principle to be established is that it is necessary to heat the air for renewing the classrooms. Ventilation can therefore only be studied in relation to heating. Whenever we wanted to obtain a renewal of air by any means, dispensing with heating the air introduced, we came up against the invincible resistance of the students, who prefer imminent asphyxiation to currents of cold air that is introduced through the vasistas or the suction cups.

From this first principle, the necessity of heating the fresh air, results an expenditure of fuel which is all the greater in proportion as a more active renewal is effected. It is therefore necessary to reduce to the necessary the renewal of air, and, for this purpose, it is necessary to know what is the sufficient quantity of air per hour and per person. It is desirable, on the other hand, that the temperature of the classrooms be between 15 and 17 degrees and the hygrometric degree between 50 and 65/100. For nursery schools, the temperature should not drop below 16 degrees.

First calculations on air renewal and CO2 levels

Knowing the capacity of the lungs and the number of inspirations per minute, it is easy to calculate that, for children, the quantity. of air consumed by each does not reach one cubic meter for three hours, the duration of each session. For this same time, the least demanding hygienists demand a renewal of 45 cubic meters per child, and when we want to do things well, we ask for at least double that.

It would therefore be necessary, according to the authors, to provide each student with a hundred times more air than actually passes through his lungs.

It is necessary to point out the very simple reason for this apparent contradiction.

Not knowing how to discover in the air the principles which alter its quality, after numerous tests in which the sense of smell served as their main guide, the hygienists almost agreed to admit the vitiation of the air. as soon as it contains a quantity of carbonic acid superior to half the normal proportion of 4 to 10,000. Thus, above 6 per 10,000, the air is considered stale. Starting from this, the carbonic acid was measured in meeting rooms and the renewal necessary to prevent the proportion of this gas from exceeding 6 per 10,000 was experimentally determined. The results thus obtained agree with those of the calculation made taking as a starting point the figure of the production of carbonic acid per person and admitting that there is produced a perfect mixture of the gases contained at each instant in the room.

Fortunately, this hypothesis of the perfect mixture is only realized if we do not know how to organize the ventilation. We have known since Darcet that exhaled air, much warmer than ambient air, immediately rises to the ceiling despite the weight of the carbonic acid it contains; most of this stale air descends along the walls and especially along the windows, which are colder, and there is a continuous gyratory movement which has the effect of intimately mixing all the gases contained in the room. When the extraction orifices are established near the parquet, the draft does not always occur in the exhaust ducts, and, in the most favorable case, much more clean air is extracted than stale air. The ideal would be to eliminate the gyratory movement, to supply new air close to each inhabitant, to let the stale air slowly rise without any eddies and to extract it as soon as it reaches the ceiling: It is through the ceiling that the stale air must be extracted, and it is from below that the new air must be introduced, after having slightly heated it. By operating in this way, the mixing of the new air with the stale air is avoided, and ventilation is achieved by passing through the room much less air than if the complete mixing of the air is allowed to take place. new air with the air that has already been used for breathing.

Such is the theoretical solution of winter ventilation; we are going to find out to what extent it is compatible with suitable heating.

Considerations on the articulation between heating and ventilation

To heat people, either radiation, conductivity or transport can be used.

Of these three means, the first is by far the most hygienic and the most pleasant, witness the well-being one experiences walking in the sun on a beautiful spring day, breathing fresh and pure air.

Chimneys, despite the considerable expense of fuel they require, are preferred in apartments because of the comfort of their heating, which acts exclusively by radiation, and no doubt also because they are a powerful means of ventilation. The radiation from the hearth heats people, walls, furniture, so that in turn all parts of the room become sources of heat. Unfortunately, even with the economy brought by the air intakes which make it possible to use more or less perfectly the heat of the smoke, the chimney lends itself badly to the use of the classes. Radiant heating is hardly obtained in schools except through steam or hot water pipes.

Heating by conductivity, used by the railways in the form of hot water bottles, has no practical application for us.

The third way, by transporting hot air is bad in every way; it is, however, one of the most widespread. Heaters and jacketed stoves have no other function than to heat the air introduced into the rooms. However, even if special devices are used to moisten it to the appropriate degree, hot air is most certainly unhealthy to breathe: it is the surface of individuals and not the inside of their lungs that must be kept at a sufficient temperature. If heaters are used, it is because there is no more economical means of heating the walls and the objects contained in the rooms: these devices heat the enclosure by bringing the heat from the fireplace through the air movement, that it is so easy to transport. This is so true that in well-organized establishments the heater is lit long before the public arrives; the air circulation is first established in such a way as to cause the air of the rooms to pass several times through the apparatus, so as to heat it strongly; then, when the public enters, the stale air intake chimneys are opened and the fire is dropped so as to introduce only the air necessary for ventilation and giving it a moderate temperature.

Péclet 's formulas , we have calculated that in a class of ordinary dimensions and containing the regulatory number of pupils, if all the exits are closed, despite the most severe cold, the heat given off by the pupils' breathing is sufficient to compensate for the cooling that takes place through the walls and the glazing.

If one were to doubt the accuracy of the formulas, it would suffice to remark that in fact, in a perfectly closed classroom, it never gets cold when the fire is completely let down. If there is an extra charge. heat from lighting fixtures, the thermometer rises rapidly. Who hasn't suffered from the excessive temperature of Parisian salons in the heart of winter, in the evenings when the audience is ever so large? And yet there are fireplaces in all the rooms where care has been taken not to make a fire and which must be ventilated more or less vigorously. There comes a time when we decide to completely evacuate the living room to open the windows wide: after ten minutes, the temperature has become excessive again, due to the heat stored in the walls. In meeting places, heating should therefore have the sole function of preventing ventilation from producing excessive cooling.

To prevent the atmosphere from becoming vitiated and overheated to the point of being inconvenient, we often have recourse to skylights; but whatever precautions are taken, the people who receive the outside air directly revolt with good reason and soon have the windows closed, unless they have the right to change places or be under the yoke of discipline , like schoolchildren. Colds, fatal lung diseases, many earaches, much more serious and more numerous than one might imagine, are attributable to the use of skylights, which sacrifice the health of some of the students. He ends up making transactions; as one student catches a cold, another is put near the terrible air vent, and only opened enough to prevent the whole class from being asphyxiated.

Good heating must achieve the double goal of bringing the walls to a high temperature before the students enter and of preventing the renewal of the air from inconveniencing any of them.

In spite of the establishment of the best apparatus and in spite of the most assiduous surveillance, we do not think that one can at present count on a perfect ventilation of the classes; it is therefore necessary, in all seasons, to require that a current of air be established there whenever work is interrupted. Under the terms of article 7 of the decree of July 18, 1882, each class is interrupted by a recreation of a quarter of an hour, and we will ask further on for more rest for young children.

Whatever the weather, it is necessary that at each interruption the children leave the classroom and that all the windows are open. If it was feared that this would result in too marked a cooling of the room, we would reply that a ventilation of a few seconds is sufficient.

Indeed, as a general rule, classes take place on both sides; the windows being open, a completely insensible wind of one meter per second suffices for the air beyond the classroom to be completely renewed in less than a minute. We will therefore lay down this rule, that at each interruption, all the windows must be wide open; their closing will take place in the same order as their opening. The time it takes to return to the first open window is more than enough to air out the class. Of course, in mild weather, the windows can remain open throughout recess; it will be for the best. Dormitory and dining hall windows will remain open for several hours a day.

Volume requirements per child in the classroom

It is with intention that we have reserved until now the question of the cube of air that the class must possess per head of child. It is known how much the obtaining of a certain cube is burdensome for the budget. By a quite unfortunate coincidence, the memorable law of March 28, 1882, enacting the obligation of primary education, had been preceded by the regulations for the construction of school houses, put into force by the decree of June 17 1880. This regulation, canceled by article 17 of the decree of July 27, 1882, required, among other ruinous conditions, a cube of air of 5 meters per pupil and contained no prescription relating to ventilation. Since the schools had been built with only 4 cubic meters per class, the regulation, by its new requirement, made almost all existing schools unacceptable with the stroke of a pen. While desiring a ceiling height of 4 meters and an area of 1.50 m per class, we affirm that we can be content, in existing schools and for appropriations, with an area of one meter and a height of 3m 30. This last figure is taken from the transmissive circular of the decree of July 14, 1858. We would like it to also be adopted for nursery schools. In all cases, provision must be made for ventilation[1]

It is easy to calculate that in an enclosed space, in order for the air to remain perfectly breathable after an hour, you need, not five, but 100 cubic meters per person. The cube of the class

[1] In no country is there a regulation requiring 5 cubic meters for children under fourteen. Wurtemberg requires 3 cubic meters, Prussia 3.9, the school board of London 4.3. The ceiling height should reach 3.2 (Prussia), 3.4 (Württemberg); all these dimensions are lower than those which have long been required in France.

should therefore be 300 meters per pupil, if it was intended to require a stay of three hours without renewal. Let us admit that these figures, generally accepted by hygienists, are excessive; let us also admit that the joints of the doors and windows and the porosity of the walls have the effect of bringing about a significant renewal of air, and that we could quantify if necessary, it remains no less certain that by giving 5 meters to the instead of 4, we have not significantly improved the situation, while committing the communes, the departments and the State to expenses the total of which no one can predict.

Air exchange requirements

The drafters of the regulations did not understand how ventilation rules applicable to meeting places differ from those sufficient for bourgeois dwellings. An individual will be able to spend his whole day in a small room of 25 cubic meters without being inconvenienced; he has for himself alone a cube five times larger than is granted to schoolchildren, and above all, through the joints of the door and the window, a permanent influx of fresh air, controlled by the call fireplace or stove. In a class of forty students, will you add forty doors and forty windows, and draw in air through forty chimneys? We hesitated to explain such obvious things, but since they have not been grasped so far by the architects in charge of building the schools, we are in the need to insist.

If there are some differences among hygienists on the cube of fresh air needed per hour and per inhabitant, all admit that the renewal figure does not depend in any way on the cube of the room. The only utility of the cube is to allow the renewal to take place without excessively violent currents; if one asks for a renewal of 15 cubic meters per hour and per person, one makes pass through a room of 5 meters three times its volume of air, while the air will have to be renewed five times in the case where the cube would be only 3 meters per inhabitant.

This condition of five renewals being perfectly realizable, one can keep the old classes whose cube reaches 3 meters per pupil, while in the new constructions it is sufficient to require 4 meters.

But in all classes and studies it is necessary to require the installation of a continuous ventilation system by means of heated air.

Unfortunately, the Commission does not believe that it is in a position to state the exact figure for the minimum renewal, and it thinks that new studies will be necessary in order to arrive at precise indications on this point. It should in fact be noted that a much less active renewal is sufficient in the case of well-combined ventilation, where the stale air escapes constantly through the ceiling, without coming down to mingle with the fresh air. The air actually consumed by a child, as we said above, does not measure 1 cubic meter for three hours. If, as in most cases, a mixture of all the air in the room is allowed to occur, we believe that we are showing great moderation by asking for a renewal of 15 cubic meters per student per hour.

One can still formulate the rules of ventilation in another form and require that the sheath of call measure 1 square decimetre by three children and that the mouths of arrival have a section at least equal to that of the sheath of call.

Technical installations for ventilation and heating

The Commission has voluntarily refrained from entering into minute details of execution; in the present state of things, precise regulations would be premature; it is necessary to show the goal to be reached and leave it to the builders to study the models they will find abroad and the authors who have written on the subject. It is to be hoped that sufficiently numerous tests will soon have been made to enable the Administration to designate a few installations worthy of serving as models for architects and contractors.

It should not be believed, moreover, that nothing has been done so far in France in the direction we are indicating. The Commission noted the perfect functioning of the devices installed at the small Condorcet high school by MM. Geneste and Herscher, under the skilful direction of M. Le Coeur; if it were not for the expense, which seems high, there would be nothing to criticize in this system, and we do not hesitate to proclaim the superiority of heating by steam, which alone fulfills all the theoretical conditions exposed in this who is before.

We have seen above that in meeting places there is an upward movement of the air which descends along the walls and windows. The stale air, thus lowered, is breathed again and rises to the floor to continue this gyratory movement indefinitely and mix with the pure air that is introduced into the enclosure. In steam installations, to avoid this circulation and this mixture, one never fails to place a steam pipe at the foot of each wall and to establish at the bottom of each window a battery through which the outside air is heated. before entering the room. This moderately warm air counteracts the downdraft and prevents mixing from taking place.

When we visited the small Condorcet high school, all the classes were strictly at the same temperature, and despite the smallness of the extraction vents, even after lighting the gas, the atmosphere seemed excellent everywhere. The entry of the air by the bases of the windows took place with a rather reduced speed and a temperature rather well regulated not to cause any inconvenience to the pupils closest to these openings.

In all heating by central appliances, call chimneys are used to extract the stale air; when the system is sufficiently well combined to allow the extraction orifices to be placed in the ceiling, the chimneys function spontaneously: it is almost a superfluity to put a few gas burners in them.

In installations where, according to the ideas of General Morin, the extraction of stale air is done near the floor, and the introduction of hot air through the ceiling, a tremendous expenditure of gas is required in the chimneys, and as one extracts masses of clean air to entrain enough stale air, the problem of the entry of clean air becomes almost insoluble: it is necessary to introduce from above torrents of air very moderately heated. We visited the heating of the Council of State, installed with all the talent possible by M. de Chabrol, according to the indications of M. Tresca , and we noted that it was necessary to heat the room beforehand by introducing the hot air from below for several hours. Despite the permanent care of a special functionary, the air does not want to move contrary to the laws of physics, and the State Councilors complain of having scalded heads and frozen feet.

After heating by circulating steam, we can recommend heating by circulating hot water, which is however less elastic.

The most widely used central heating system on our continent is the calorifer, which has been much criticized, no doubt because it is generally poorly applied. The builders forgot Darcet's prescription, according to which the air coming out of the heat registers should not have a temperature higher than 20 degrees. The inquiry made in Bavaria by Bezokl and Voit concludes in admitting without hesitation the use of calorifiers, which are economical and provide ventilation.

When using the heaters, they should be constructed of metal as far as possible, the heating should be done by large quantities of air at a maximum of 30 degrees, precautions should be taken for the humidification of the air, and the Intake vents will be placed at the bottom of the windows. The evacuation openings will be placed at the bottom and at the top of the wall, the last ones having to be used preferably, as long as the temperature will not drop too much.

After having recommended steam for large installations and the calorifer for medium-sized installations, we must resign ourselves to the use of stoves for small schools, in spite of the serious inconveniences they present. The indisputable discomfort and the bad odor caused by the stove on an open fire are probably not attributable to the passage of carbon monoxide through the red-hot cast iron. The bad smell seems to come from the calcination of organic particles floating in the air: nothing proves that it is harmful. As for the discomfort caused by the stoves, we attribute it, with M. Coulier , to the desiccation of the air and also to the absence of ventilation.

Since Francklin , all countries have seen the emergence of innumerable ventilation systems operated by chimneys or stoves; the multiplicity of these systems shows that none is absolutely satisfactory. The difficulty lies in the fact that the fresh air, after having warmed up in the double envelope of the device, rises before having been used for breathing. If the extraction orifices are in the ceiling, they suck in this new air which has been unnecessarily heated; if they are at the bottom, they are very likely not to work. It is not enough to show arrows on a project for the air to agree to follow the direction assigned to it.

In the construction of stoves, care must be taken to arrange the heat vents as low as possible without ceasing to have sufficient draft and try to give a downward direction to the air they emit [2]. As for the extraction ducts, a recommended arrangement is to make two openings, one at the top and the other at the bottom, controlled by two hatches made integral by means of a rigid rod: the master is then obliged to open one by an amount equal to that with which it condemns the other. In spite of all these indications, the 1st Sub-Committee does not hesitate to say that in all cases where this is possible, a general appliance should be preferred to special appliances for the heating of schools.

If the hesitations of the practice still prevent us here from formulating detailed indications on the use of the stoves, we can at least ask for a minimum of guarantees, thus defined: The keys of the pipes of stoves are prohibited; the adjustment of the fire must be done by means of the ashtray. Every stove will be equipped with a large basin containing water. The use of the stove is prohibited in schools where there is no duct for the evacuation of stale air [3].

Ventilation of premises other than classrooms

So far we have only spoken of the ventilation of the classes: for the PRIMARY SCHOOLS and the NURSERY SCHOOLS it will be necessary, according to the same principles, to ensure the ventilation of the covered courtyards and the corridors. The cloakroom deserves a special mention: it would be very desirable for it to be strongly heated and with as dry air as possible when the children have left

[2] Douglas Galton's model with a flue pipe passing under the floor and the stove recently experimented with in some schools in Paris, with an almost horizontal pipe running along the bottom of the glazing, seem to us to come closest to the goal at present.

[3] In several countries, keys are prohibited; in Berlin, they are not even tolerated in private homes. For their replacement, and for the indication of the water basin, see Coulier (Economic ventilation and heating of cafes, asylum rooms, etc.; Lille, 1872, L. Danel printing); see also the article Heating, by the same author, in the Encyclopedic Dictionary of Medical Sciences.

their wet clothes there; but this heating would be absolutely useless if we did not add to it an energetic call for air.

The private ones must also be ventilated, especially if they are not separated from the main building; and as they are not heated, it will be well, in urban schools, to keep a constantly burning gas-light in the air-duct. In a number of American schools, the private ones are heated so that, during the cold weather, the children are not tempted to resist the fulfillment of their natural needs, which indeed presents the most serious inconveniences.

The case of the Normal Schools

It remains for us to speak of the special premises at the boarding schools and in particular at the NORMAL SCHOOLS. If there are study rooms, they must be ventilated with as much care as the classrooms, because if the air cube is generally a little larger, by compensation the stay of the pupils is longer there. We think, moreover, that in new normal schools the simplest and most economical way is not to have study rooms. We fully understand the need for these rooms in high schools; in the absence of external students, several classes can be combined in a single study and thus simplify the lighting, heating and surveillance services.

Three classes each containing a promotion, a drawing room calculated for two promotions, a physics and chemistry amphitheater that can contain the three promotions, a room for singing and geography, sheds for chemical manipulations and manual work, it no more is needed.

If you want a single supervisor to suffice for the three years, nothing could be simpler than to put double doors between the classrooms, closing tightly to deaden the noise, and leaving them open during the study; the supervisor would stand in the middle room and circulate as needed, in the very rare case that discipline required it. The student-masters, on the whole, are reasonable enough for the slightest supervision to suffice.

Requiring that a normal school be equipped with a good ventilation system, we can content ourselves with an area of 1m50 per pupil for the classes, the height under the ceiling must not be less than 3m50.

The brevity of the pupils' stay in the refectory makes it possible to dispense with the necessity of establishing ventilation there: open the windows a moment before the meal and open them again immediately afterwards, and you will have a tolerable condition.

On the contrary, for the dormitories, we admit our inability to obtain a satisfactory result, unless we resort to the expensive solution of a slight permanent heating of the fresh air during cold weather. It is perhaps in the climate of Paris that it is most difficult to make a proper determination in this respect. Under a more rigorous sky, one will not hesitate to establish a heating system, and from then on it becomes easy to ventilate. In a milder climate, ventilation can be made by admitting the outside air with suitable precautions to prevent it from striking the inhabitants directly. Although it is not mentioned in any author, it seems to us that the question of the height of the beds above the ground is absolutely linked to the problem of ventilation. The English, who ventilate by means of a very large number of small orifices placed in the cornice, have been led to use extremely low beds, no doubt to keep the sleepers as far away as possible from the current of air which is established near of the ceiling under the influence of external winds and which removes the upper layers of air from the room. In the event that an attempt is made to ventilate by letting fresh air enter flush with the floor, it would undoubtedly be advantageous to use beds as high as possible. A ventilation test by introducing fresh air flush with the floor, made this year by M. Vieillot, director of the normal school at Auxerre, seems to have given good results, even without raising the beds; but we cannot yet decide, the winter of 1883-1884 having been exceptionally mild.

Until we are well settled on these difficult questions, the 1st Sub-Commission thinks that a cube of 25 meters is desirable and it admits a cube of air of 16 meters as a minimum for the dormitories.

It perfectly accepts the layout putting on the ground floor rooms for the dual purpose of classes and studies and superimposing three floors of dormitories for the three promotions: this arrangement obviously makes it possible to build suitable normal schools at little cost.

It goes without saying that in all respects it is best to avoid boarding schools; the smallest small room in town is preferable to a box in the most luxurious of dormitories, and if we did not know the relentlessness of routine, we would ask for the transformation into day schools of the normal schools for teachers, in the interest of morals and student health.

Installation of plants in schools

We are told, when we are correcting this last proof, of the advantage that there would be in maintaining plants in the schools. We believe that certain houseplants (dracena, phoenix, dwarf palm, etc.) deteriorate very quickly when kept in an atmosphere that is too dry. Their presence in a classroom is a guarantee of maintenance. of a suitable humidity level.