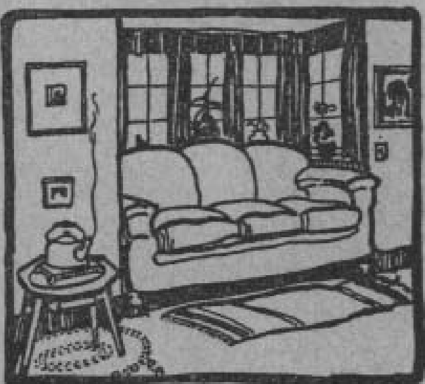
# Humidity in house heating



## The cause and control of air dryness in house heating

NATURAL RESOURCES INTELLIGENCE SERVICE
DEPARTMENT OF THE INTERIOR
in co-operation with
THE DOMINION FUEL BOARD

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# Humidity in House Heating

## THE CAUSE AND CONTROL OF AIR DRYNESS IN HOUSE HEATING

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The purpose of this pamphlet is to direct public attention to the fact that, with few exceptions, the air in houses during much of the artificial heating season is excessively dry—drier than that of the driest deserts. It points out that such excessive air dryness—harmful to health, and destructive to interior decorations and woodwork, furnishings and clothing—is inevitable unless special provision is made for the evaporation of the water required to maintain the healthful relation between air temperature and air moisture. It also points out that this important phase of house heating is almost entirely ignored in most present-day heating equipment in common use, with the result that fuel which should be used to evaporate water for healthful humidification of the air at the moderate comfort temperatures so required is used to maintain the unduly high temperatures of 72 to 75 degrees required for comfort under dry air conditions.

In outlining the essential facts bearing on Humidity in House Heating and in indicating practical methods together with types of apparatus for the obviation of undesirable indoor dry air conditions during the winter, the main object in view is not only to further the cause of good health but to promote the more efficient employment of the fuel used in the heating of Canadian homes, offices, and factories.



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## INTRODUCTION

MANY people believe that excessive "dry air" conditions in house heating are to be found only in those houses heated by hot-air furnaces, but the fact is that this type of heating equipment is practically the only one in common use in which provision is made to moderate such conditions.

The moisture capacity of air increases with rising temperatures. Thus cold air saturated with moisture becomes "dry air" when heated—not because moisture has been removed but because of its additional moisture capacity.

Under natural heating conditions the large water surfaces of the earth and the moisture from vegetation are the principal sources from which the increased moisture capacity of the heated air is sufficiently satisfied to obviate "air dryness"—except in the deserts, where the heated air remains dry.

Very material progress has been made since primitive times in the design of artificial heating equipment—from the smoky open fire in the middle of the floor of each chamber to the efficient modern centralized furnace or boiler equipment. But it is only within recent years that the question of maintaining healthful air-moisture conditions in houses has received serious attention. With comparatively few exceptions "dry air" indoor conditions are the rule—alleviated by chance evaporation of water in kitchen



and other household operations and in some cases by the special evaporation of inadequate quantities of water in water pans, etc., but also usually intensified by the admission of large quantities of cold outdoor air through open windows to secure adequate ventilation.

It is true that the human organism adapts itself to such "dry air" conditions with little apparent discomfort, but in so doing it becomes susceptible to colds, sore throat, influenza, skin troubles, and other ailments through the weakening of tissues abused and overworked by an unnatural atmospheric condition.

The question of the maintenance of precise conditions of temperature, humidity, and air cleanliness as demanded by certain industrial processes has been thoroughly investigated, and as a result various types of effective air-conditioning apparatus have been evolved and are in general use in such industries. Similar equipment has recently been made available for use in theatres, hospitals, schools, and large office buildings, and no doubt will eventually be simplified and adapted to the needs of the small house.

In the absence of such complete air-conditioning equipment which will secure to the householder healthful indoor temperature, humidity, and air cleanliness, it is extremely desirable that the present injurious "dry air" conditions be remedied by the use of special humidification devices such as are at present available.

# SECTION I: AIR MOISTURE





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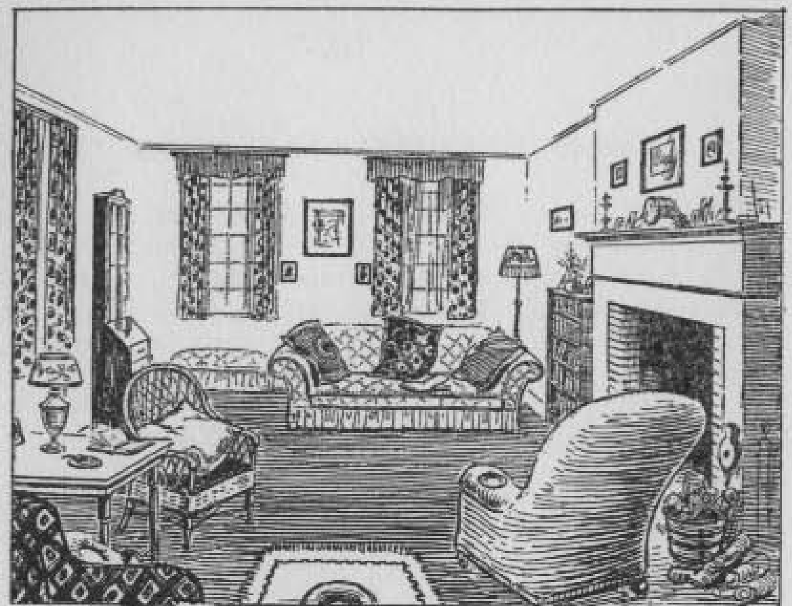
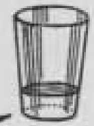


THIS LIVING ROOM IS 13 FEET WIDE, 20 FEET LONG AND 9 FEET HIGH. ITS CUBIC CONTENT IS 2340 CUBIC FEET.

AT ZERO (0°) FAHR. THE AIR OF THIS ROOM CAN HOLD WATER TO THE EXTENT OF 1/8 PINT. EQUAL TO 1/4 GLASSFULL.



AT 69° FAHR. THE SAME AIR CAN HOLD WATER TO THE EXTENT OF 2 PINTS EQUAL TO 4 GLASSFULS

THUS COLD DAMP AIR BECOMES DRY ON HEATING BECAUSE ITS ORIGINAL MOISTURE CONTENT ONLY PARTIALLY SATISFIES ITS NEW, INCREASED MOISTURE CAPACITY.

FIGURE 1.

# AIR MOISTURE: RELATIVE HUMIDITY

THE air which envelops the earth and forms the atmosphere is a mixture of oxygen and nitrogen with varying quantities of water vapour, dust, and other substances. Water vapour is always present in quantities which depend principally upon temperature, winds, and the character of the earth's surface.

## *Moisture Capacity of Air Depends on Temperature*

The quantity of water vapour which air can hold, or its moisture capacity, varies with the temperature. Raising the temperature increases the moisture capacity while lowering the temperature reduces it, the excess moisture condensing to form fog or mist as when the outside door of a warm room is opened on a very cold day.

For example, the air required to fill an average size living room 13 feet by 20 feet with a 9-foot ceiling (2,340 cubic feet) at zero Fahrenheit can hold moisture to the extent of only one-eighth of a pint of water, whereas at 30 degrees it can hold half a pint and at 69 degrees practically two pints, or sixteen times as much as at zero (Figure 1).

Saturated air, or air that is charged with all the moisture it can hold, becomes therefore only partly so when heated, and in that condition absorbs further moisture if such is available until its capacity at the new temperature is fully satisfied.



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*Relative Humidity*

The relation between the actual moisture content of the air at any temperature and its capacity for holding moisture at that temperature is known as its "relative humidity." It is expressed in percentage, and is thus a convenient expression to denote the intensity of the thirst of air for water, since the lower the relative humidity the more rapidly will moisture be absorbed.

*Normal Relative Humidities*

The average relative humidity of air over the land surface of the globe is probably about 60 per cent, whereas that over the oceans is about 85 per cent. In the settled portions of Canada the relative humidity during the period of artificial heating varies from about 70 per cent to 100 per cent, the higher values being usually found with low and descending temperatures.

## THE CAUSE OF AIR DRYNESS IN HOUSES

Air is said to be dry when its relative humidity is low, that is, when its capacity for moisture is largely unsatisfied. Death Valley in California with an observed relative humidity of 23 per cent has one of the driest atmospheres of North America.

The outdoor temperature for a large part of the Canadian winter is well below the freezing point and the relative humidity is usually high—100 per cent at times.

Cold air with high relative humidity, but actually containing little moisture, is thus constantly circulating through the houses, displacing the warm air therein,



being itself warmed and finally displaced by other incoming cold air at a rate of one, two, or more changes per hour, depending on ventilation, air leakage and infiltration, wind velocities, etc. Raising the temperature of such cold humid air from say 15 degrees, which is not an unduly severe winter temperature, to an indoor temperature of 69 degrees increases its moisture capacity eight times. Thus, assuming the outdoor relative humidity to be 100 per cent and that no moisture is added as the temperature is raised, the new relative humidity would be only 12½ per cent, which is considerably lower than that of the driest outdoor atmosphere of the continent as already noted. This is not an extreme case as humidity measurements taken in large airy offices in Ottawa, with ample window ventilation but not provided with artificial humidification, have shown relative humidities as low as 8 per cent in moderately severe weather.

It is apparent from the foregoing that *artificial humidification must accompany artificial heating if dry air conditions are to be obviated.*

## THE EFFECT OF AIR DRYNESS IN HOUSE HEATING

*Comfort and Fuel Consumption*

The American Society of Heating and Ventilating Engineers has carried out extensive researches relating to the comfort or feeling of warmth experienced by the average person under varying conditions of temperature and relative humidity. The results of these researches are definite, showing that the same degree of comfort is experienced in air at 68 degrees with a relative humidity of 50 per cent as at 72 degrees with a relative humidity of 10 per cent.

The lower temperature required with the higher relative humidity for comfort would mean an appreciable economy in fuel consumption for purely heating purposes. A considerable portion of the fuel thus saved would, however, be required to evaporate the water necessary to secure and maintain the higher relative humidity. It has been stated that the net saving in fuel amounts to 5 per cent or more. Reliable information on this point is, however, not yet available.

### *Health*

Dry air at the usual room temperatures is injurious to health. It tends to dry up the mucous membranes of the nose, throat, and lungs, weakening the resistance of these organs to the disease germs carried in large part by the dust which it is an important factor in creating. It has a drying and harshening effect on the hair and skin. The excessive evaporation of moisture from the skin in dry air with its abnormal loss of heat requires the maintenance of high temperatures for warmth. Authorities point out that these high temperatures produce an enervating effect and cause nervousness and irritability.

### *Woodwork and Furnishings*

Dry air has also a most injurious effect on the interior woodwork of houses and on furniture, abstracting the normal moisture content from the wood and causing it to shrink and check. It is destructive to paintings. It also contributes materially to the disintegration of textile fabrics used for clothing and furnishings—the fibres of which on loss of normal moisture become brittle, breaking into fluff and dust particles.



## DESIRABLE RELATIVE HUMIDITY IN HOUSES

Medical authorities in general agree that a relative humidity of at least 40 per cent is necessary for health under the usual conditions of artificial heating. It is found that with the severe winter temperatures excessive frosting or condensation of moisture takes place on the windows (even when double windows are used) when the relative humidity runs above 50 per cent.

*Thus practical considerations fix relative humidities of from 40 to 50 per cent as being the most desirable for Canadian conditions of house heating.*

Very high relative humidities are as undesirable in artificial heating as they are in warm summer weather. They cause sultriness and stuffiness, prevent normal evaporation of moisture from the skin, and weaken bodily resistance to sudden changes of temperature in going from warm humid air to sharp outdoor winter atmospheres. They cause excessive condensation of moisture on the walls, encourage fungous growth and mildew, and they hasten the corrosion of iron and steel fittings and utensils as well as the decay of woodwork.

## THE PREVENTION OF AIR DRYNESS IN HOUSES

The prevention or obviation of air dryness in houses is simply a question of providing sufficient moisture to satisfy to the desired degree the increased moisture capacity of air brought about by artificial heating.

The quantity of water which must be specially supplied for the maintenance of an indoor relative humidity of from 40 to 50 per cent during the heating season depends upon several variable factors among which may be mentioned:—

1. Outdoor temperature.
2. Outdoor relative humidity.
3. Indoor temperature.
4. Rate of air change in the house due to ventilation, air infiltration and leakage, wind velocity, etc.
5. Quantity of water evaporated in everyday household operations.
6. Number of people in the house.

*Theoretic Moisture Requirements*

It has already been pointed out that the air of the average small living room, 13 feet by 20 feet with a 9-foot ceiling, containing 2,340 cubic feet, at zero temperature can hold one-eighth of a pint of water. At 69 degrees its moisture capacity would be two pints, or with a relative humidity of 50 per cent its moisture content would be one pint. Seven-eighths of a pint of water would therefore have to be added to the air of this room to obtain a relative humidity of 50 per cent in heating from zero to 69 degrees with an original relative humidity at zero of 100 per cent. With only



one change of air per hour[1] the quantity of water to be evaporated per day under these conditions would be $24 \times \frac{7}{8} = 21$ pints or $2\frac{5}{8}$ gallons. A small house of six times this cubic content, or 14,040 cubic feet, would require, in theory, the evaporation of nearly sixteen gallons of water per day under such conditions.

In actual practice average indoor temperatures during the winter are appreciably lower than 69 degrees. Thus the quantity of water to be evaporated per day is not so large as that given—assuming an average outdoor temperature of zero and only one air change per hour. Moreover, a portion of the moisture required for the maintenance of healthful humidity conditions is supplied by the evaporation of water in ordinary household operations.

*Actual Moisture Requirements Cannot be Arbitrarily Fixed*

It has been stated that the average smaller type house requires the special evaporation of from eight to twelve gallons of water per day during the heating season. The fact is that under favourable conditions on a comparatively mild day the evaporation of three or four gallons per day may give ample humidification, whereas on a severely cold day with high winds the evaporation of sixteen gallons may not be sufficient to give the same relative humidity. The daily quantity of fuel used for heating is subject to the same wide variation since the hundred pounds of coal burned on a cold, blustery day gives no higher

[1] The rate of air change in a well built house with double windows is placed by various investigators at from one to three changes per hour depending mostly upon wind velocity, exposure, difference between outdoor and indoor temperatures, ventilation, and use of fireplace.

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indoor temperature than the twenty-five pounds burned on a mild day. A definite objective is set in either case. In heating, that objective is a uniform comfort temperature—maintained by burning varying quantities of fuel as demanded by changing weather conditions. In humidification, the objective is a relative humidity of from 40 to 50 per cent—the quantities of water to be evaporated for its attainment being determined by the same changing weather conditions.

In the matter of house temperature the householder relies upon his sense or feeling of warmth or, as has now become a fairly general practice, upon his thermometer as a guide to enable him to control his furnace or boiler. In the matter of humidification, however, he has practically no "sense" of air moisture, except in extreme cases. He will readily recognize excessive air dryness in his house by the "dry feel" of the air, the shrinkage of woodwork and furniture, the presence of "static," the wilting of common house plants, and the necessity of unduly high temperatures for warmth. *His only certain method of ascertaining whether sufficient water is being evaporated for healthful humidification is by keeping a close check on results as determined by a relative humidity measuring instrument, the most common type of which is the hygrometer.*

## HUMIDITY CONTROL: MEASUREMENT OF RELATIVE HUMIDITY

Humidity measuring instruments vary from the novelty type giving approximate information, and generally known as hygroscopes, to the highest grades



of hygrometers of the recording type giving a continuous record of the most accurate humidity information. Those suitable for household use may be divided into two broad classes.

Instruments of the first broad class employ substances that are sensitive to moisture such as hair, catgut, and whalebone. The cheaper instruments of this class give only a general indication of the moisture content of the air and are thus not of much practical value. The better instruments of this class (Figure 2) are accurate and reliable, provided that comparison is made from time to time with a standard instrument to make certain of correctness of adjustment.

Instruments of the second broad class combine two thermometers, one of which is arranged to give wet bulb temperatures (Figure 3), or employ a single thermometer arranged to give both wet and dry bulb temperatures. The accuracy of humidity determinations made by a hygrometer of this class depends therefore upon the accuracy of the thermometers of the instrument. Both dry and wet bulb temperatures are read (the latter being the lowest reading obtainable on the wet bulb thermometer on vigorously fanning the instrument with a fan or sheet of cardboard) and the corresponding relative humidity is taken directly from prepared tables or charts. One variation of this class is the swing psychrometer in which highly accurate dry and wet bulb thermometers are arranged to swing about a swivelled handle or at the end of a short chain (Figure 4). It is used where an easily portable instrument giving determinations of the greatest accuracy is required. Hygrometers of the dry and wet bulb type

FIGURE 2. HYGROMETER USING SUBSTANCE SENSITIVE TO MOISTURE CHANGES

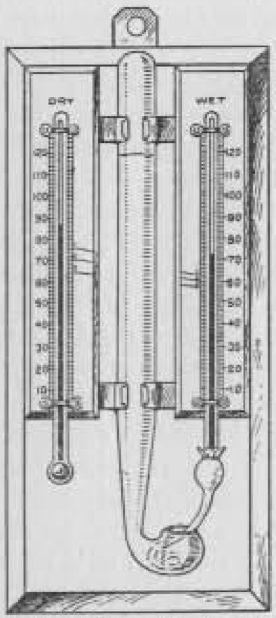



FIGURE 3. WET AND DRY BULB HYGROMETER

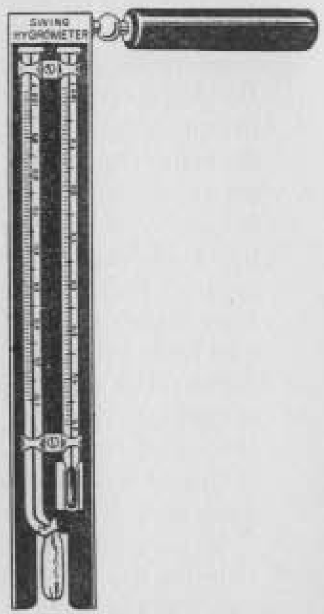



FIGURE 4. SWING HYGROMETER



are simple in construction, are not unduly expensive, and may be used by anyone who can read a thermometer.

Some types of household thermometers may be adapted to give wet bulb temperatures as explained in the Appendix on page 31, which also explains how a hygrometer may be improvised from two ordinary household thermometers, and includes a table showing relative humidities corresponding to the usual range of wet and dry bulb temperatures under average conditions of house heating.

In measuring the relative humidity in a room care must be taken to place the hygrometer at some point where air conditions are approximately average for the room. The point selected should be between four and five feet from the floor and at some little distance from radiators, hot-air registers, and outside walls, and should not be in an appreciable draught.

## SECTION II:

# HUMIDIFICATION OF AIR IN HOUSES

## GENERAL TYPES OF HUMIDIFICATION EQUIPMENT

SINCE air dryness in houses is the direct result of artificial heating, the obvious remedy is the provision of humidifying apparatus that will operate in conjunction with the heating equipment. Such an arrangement tends to be automatic in operation inasmuch as the quantity of water which must be evaporated for the maintenance of healthful humidity conditions is determined by essentially the same factors as determine the quantity of fuel that must be burned to maintain the normal comfort temperature, viz., outdoor temperature, ventilation, air leakage, winds, etc.

Where it is not practicable or convenient to install humidifiers to be operated in conjunction with the heating equipment, humidification of indoor air may be readily effected by the use of humidifiers independently operated.

Heating equipment in common household use is of two different types. First is the radiant type in which the fuel is burned in a stove and the heat therefrom radiated directly into the room, or in a boiler from which the heat is conveyed by steam or hot-water circulation to radiators and thence radiated directly into the room as before. Second is the air-circulating type in which the fuel is burned in a hot- or warm-air furnace and the heat conveyed to the various rooms by the circulation through the furnace jacket of the air of those rooms. Humidifiers for use with each of these types have been devised and made available.





Household humidifiers may therefore be divided into two broad classes, as follows, the first class being further subdivided as indicated:—

I. Humidifiers operated in conjunction with heating equipment of:
   - *(a)* air-circulating type.
   - *(b)* radiant type.
   - *(c)* either type.

II. Humidifiers operated independently of the heating equipment.

## INFLUENCE OF AIR CURRENTS OR AIR FLOW IN HOUSES ON ARTIFICIAL HUMIDIFICATION

The flow of air within a house during the heating season is subject to many influences and is thus very complex in character. Air rises when heated and falls when cooled. Thus in a closed space, as a room, a definite circulation of air is created by supplying heat at one point and abstracting it from another.

In a house, heat is supplied either by means of a hot-air furnace or by stoves, hot-water or steam radiators, electric heaters, etc., while it escapes through the walls, windows, doors, and roof, thus providing the necessary conditions for air circulation. In addition, fresh cold air is constantly entering the house by infiltration through the walls, through cracks around windows and doors, and by way of such ventilation facilities as may be provided, the displaced warm air leaving through similar channels. The rate of air change is dependent not only upon the character of construction of the house walls but also upon the strength of the wind and upon the difference between outdoor and indoor temperatures. This air change provides another definite circulation of air within the house.

The division of the house into a number of rooms, each of different exposure, at different elevations, interconnected by openings varying in size as the doors are opened and closed, and maintained at different temperatures, further complicates the air circulation within the house by adding the circulations between these various rooms.

With a well designed air-circulation heating equipment using a hot- or warm-air furnace, the cool air is conducted through "cold-air" ducts to the furnace jackets, where it is heated and distributed throughout the house by means of the hot-air leaders and registers. This type of equipment serves thus not only as an air heater, but also as an air mixer. Uniform humidification to the desired degree can therefore be readily accomplished by the evaporation of the necessary quantity of water into the air circulation at the point where it is concentrated, viz., in the furnace jacket.

With the other types of heating equipment in common use in which each room is heated by means of its own hot-water or steam radiator or stove, there is no such definite circulation of air throughout the house, although the circulation within each room is just as positive. The uniform humidification of air throughout the house is therefore a more difficult problem to solve. Theoretically, each room should be provided with its own humidifier. However, practical considerations of cost and convenience compel the adoption of a compromise. A study of the air-circulation conditions in each individual case would enable the selection of the one, two, three, or more points at which moisture should be supplied to give fairly uniform and ample humidity conditions. It is usually found that the selection of these points in or near the most important heating elements in the principal living rooms and main halls will give effective results. Care should be taken, however, that they are not subject to cold draughts which would result in condensation of moisture on the adjacent wall or on the floor.



## HUMIDIFIERS OPERATED IN CONJUNCTION WITH THE HEATING EQUIPMENT

### (a) *With Air-circulating Equipment: Hot- or Warm-air Furnaces*

Hot- or warm-air furnaces are generally considered as particularly productive of air dryness in houses. This method of heating employs the air of the house to convey the heat from the fuel to the various rooms. Large quantities of warm air issue from the registers at high temperatures (150 degrees or more) which while very dry at those temperatures are no drier when reduced to normal room temperature than would be the case with hot-water or steam heating.

One of the important advantages of this type of heating equipment is the ease with which ample humidification may be effected. The evaporation of water into the air circulation is a very simple matter.

SKETCH SHOWING TYPES OF HUMIDIFIERS FOR HOT OR WARM AIR FURNACES

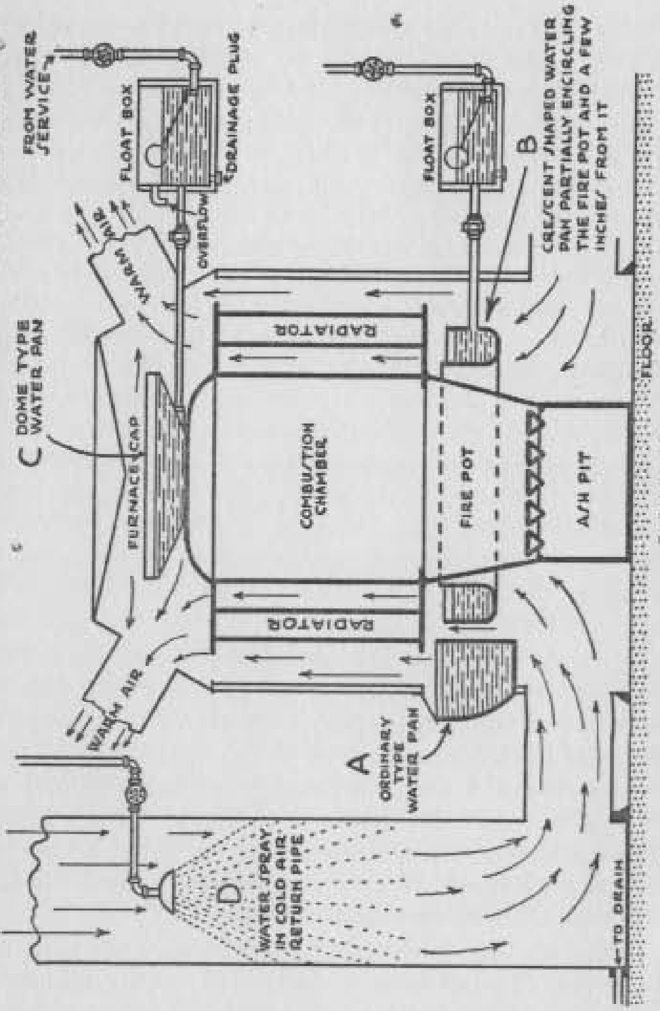



FIGURE 5. A ORDINARY TYPE WATER PAN C DOME TYPE WATER PAN
B CRESCENT TYPE WATER PAN D SPRAY TYPE HUMIDIFIER



All hot- or warm-air furnaces are equipped with water pans, usually placed beside the fire-pot near the firing door, and filled by hand (Figure 5A). In very many cases, however, the quantity of water evaporated from these pans is so small by reason of restricted water surface and unfavourable location that little benefit results.

Some warm-air furnaces, however, have provision for the more ample humidification of the air circulation. This may be in the form of a crescent-shaped water pan almost encircling the fire-pot (Figure 5B). This may be kept filled by hand, or the water may be automatically supplied by means of a float-box connected with the water service. Another type of evaporating pan used by some furnace manufacturers or made for installation on any furnace, is placed on top of the dome or combustion chamber and is also automatically supplied with water by means of a float-box (Figure 5C). Tests made by the University of Illinois show that this type of pan evaporates nearly a pound of water per square inch of exposed water surface per day, whereas under the same firing conditions the crescent-shaped pan evaporates little more than two-thirds of a pound, and the ordinary type less than half a pound in the same time. These pans, if adequate in size, give effective results and, the water supply being automatically controlled, require little attention except an occasional cleaning.

Equipment of the dome type can be made and installed at a reasonable cost by any tinsmith or plumber using sheet copper or galvanized iron for making the pan and float-box. The pan should be made to provide a large water surface, and with the sides sloping as in Figure 5c, so that this surface may be adjusted to the needs of the house by changing the level of the water in the float-box. In determining the area of the water surface required in a water pan of this type the heating capacity of the furnace in use must be taken into account as well as the size of the house, since an undersize furnace operated with a hot fire will evaporate more water from a pan with a given surface than an over-size furnace operated with a slow fire.

A humidifying device of another type consists of a spray nozzle which is placed at the upper end of a vertical section of the principal cold-air return pipe near the furnace (Figure 5D). This specially designed nozzle is connected with the water service and directs a fine misty spray vertically downward through the pipe moistening the air circulation as well as cleansing it of dust and soluble impurities. The surplus water is collected in a boot and drained into the house drains. This humidifier uses about 200 gallons or more per day (depending upon the pressure), of which it is claimed that from 10 to 20 gallons are evaporated into the air.

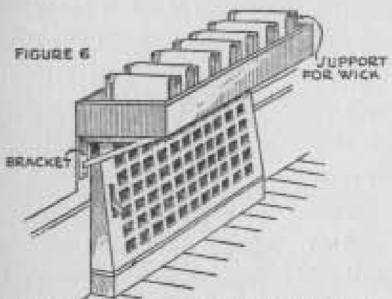
Where it is not desired to alter the humidifying equipment on the furnaces, shallow evaporating pans may be supported on brackets or placed in shields over the warm-air register in such a way as not to impede the flow of warm air. Large water surfaces are required on such pans in order to evaporate appreciable quantities of water, and wicks are usually arranged to obtain these large evaporating surfaces (Figure 6).



A simple makeshift humidifier may be assembled from material to be found in every house together with a few sheets of blotting paper and used to good effect with baseboard registers as follows: A bowl or pan holding half a gallon or more of water is placed on the floor in front of the register (Figure 7). Long strips of blotting paper are strung at one end on a piece of wire which is supported on brackets fastened either to the pan or to the wall (or which is bent to such shape that it can be clamped to the upper part of the register grill) so that the lower ends of the blotting paper strips hang into the water. The stream of warm air passing between the saturated strips rapidly evaporates the water in the pan. The blotting paper which is used to increase the evaporating surface may be replaced when it becomes unsightly by reason of staining from the impurities in the water.

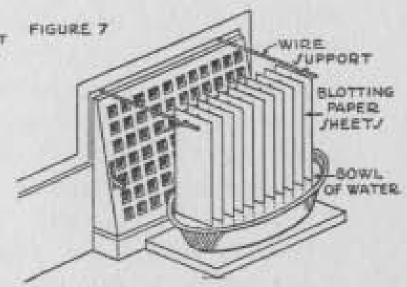
Such auxiliary water pans are kept supplied with water by hand. The number required to give ample humidification can be determined only by checking results with a hygrometer.

FIGURE 6




WATER PAN FOR BASEBOARD OR WALL REGISTER FITTED WITH A FABRIC WICK TO INCREASE EVAPORATING SURFACE.

FIGURE 7




HOME MADE HUMIDIFIER FOR BASEBOARD REGISTER *(b) With Radiant Equipment: Hot-water or Steam Radiators, Stoves, etc.*

The satisfactory humidification of air with heating equipment of this general type where there is no concentration of air circulation is not so simple a proposition as with circulating equipment, except where stoves only are used, in which case kettles kept filled with water are usually sufficient.

The usual type of air moistener is a long shallow pan of sheet copper or galvanized iron placed on top of the radiator (Figure 8). These pans may be obtained in various sizes and are frequently concealed in radiator covers. As the radiator temperatures under normal conditions, particularly of hot-water radiators, are comparatively low the rate of evaporation from these pans is correspondingly low. This is partially remedied in some types by the use of absorbent wick placed on grids or supports to increase the evaporating surface as in Figure 6.

Other types of water pans are designed to hang behind the radiators or to be placed between the coils. As the free water surface of such pans is necessarily restricted in area, wicks are used to increase the evaporating surface. When such wick is a towel large enough to almost cover the back of the radiator appreciable quantities of water are evaporated.

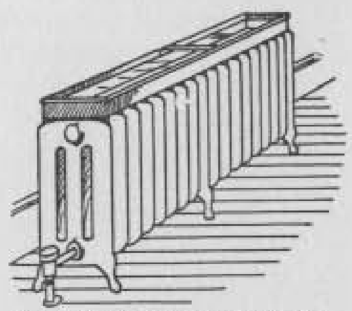


FIGURE 8. WATER PAN FOR STEAM OR HOT WATER RADIATOR



Water pans for use on radiators are all supplied with water by hand. The radiators to be so equipped are those which are in most constant use, and the number is determined by results in humidification as measured by the hygrometer.

With steam-heating equipment a special valve designed for the purpose may be attached to the radiator for the continuous liberation of a small quantity of steam into the room. Care should be taken to see that the steam so liberated is deflected away from the walls and is not in sufficient quantity to cause a drip on the floor.

*(c) With Either Air-circulating or Radiant Equipment*

Several humidifiers are now on the market which make use of a retort or vaporizer placed in the fire-box of the boiler or furnace. This is connected to the water service and the quantity of water which is vaporized is determined first by a valve adjusting the flow of water, and second by the intensity of the fire—being thus semi-automatic in action. The water so vaporized is distributed throughout the house by means of well insulated pipes leading to one, two, or more outlets in the halls and principal rooms. These outlets are placed at points, either in or near the principal radiators, where there will be the minimum condensation by chilling draughts. In the case of hot-air equipment the vapour from the retort may be conducted directly into the air circulation in the furnace jacket or cap.

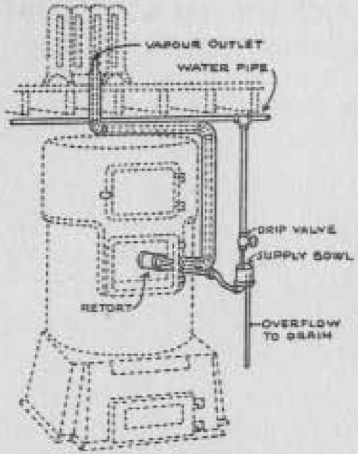



FIGURE 9. SKETCH SHOWING RETORT TYPE HUMIDIFIER

The component parts of equipment of this kind are indicated in Figure 9. While complete equipment ready for installation is on the market, any steamfitter or plumber can make up the necessary parts from odd pieces of pipe to be found in his shop and standard pipe connexions and valves.

Another type adaptable to either furnace or boiler equipment makes use of the waste heat of the smoke pipe for the evaporation of water, the vapour being distributed as in the retort type (Figure 10). A water jacket encircles a pipe which is substituted for a section of the regular smoke pipe, the water being maintained at a predetermined level by means of a float-box connected with the water service.

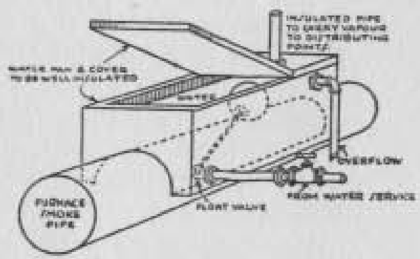



FIGURE 10. SKETCH SHOWING SMOKE PIPE TYPE OF HUMIDIFIER



## HUMIDIFIERS OPERATED INDEPENDENTLY OF THE HEATING EQUIPMENT

Humidifiers or air moisteners designed to operate independently of the heating equipment are available in many types. They are usually handled by dealers in hardware, electrical supplies, and heating equipment.

Many of these humidifiers are electrically operated, and being portable, may be used in any room in which electrical current is available.

One is the atomizer type. This device discharges a very fine spray of water vapour into the room from a jet in much the same manner as an ordinary nasal atomizer. A small electric motor drives an air compressor to furnish the air pressure for its operation. The spray must be so fine that it will be quickly and thoroughly evaporated. Another type creates a spray by centrifugal force. A small electric motor revolves a disk at high speed. The water flows onto the disk and is thrown against a series of stationary blades surrounding the circumference of the disk, forming a fine spray which is forced out into the room where it is quickly evaporated. Still another type uses an electric fan to pass a current of air over a slowly moving surface consisting of a fabric belt which is kept wet by passing through a water reservoir. Humidifiers of this general type employ the heat of the air obtained from the heating equipment for the evaporation of the water, the only current required being that necessary to operate a small motor. In others the water is evaporated by means of a heating element placed in the water container. The same results may be obtained by using a small electric plate or grill to evaporate

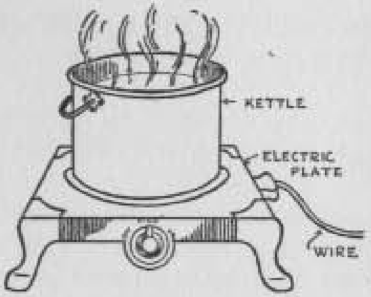



FIGURE 11. ELECTRIC PLATE AND KETTLE

water from a kettle (Figure 11). Care should be taken to use insulating mats to protect the stands upon which electric humidifiers of this type are placed and to use switches that will automatically cut off the current when the water container becomes dry. It should be pointed out, however, that the evaporation of water by electricity, as in these devices, is more expensive than by the house-heating plant, even with the most favourable rates for current.

With few exceptions small portable electric humidifiers are kept supplied with water by hand.

Another type of humidifier utilizes a spray of water from the water service (Figure 12). This fine spray from a specially designed nozzle is directed vertically downward in a long box placed vertically on the wall, or built into it. The box has openings into the room on one side near each end. The fine spray induces a circulation of air through the box; the air, which enters at the upper opening and leaves at the lower, being moistened and

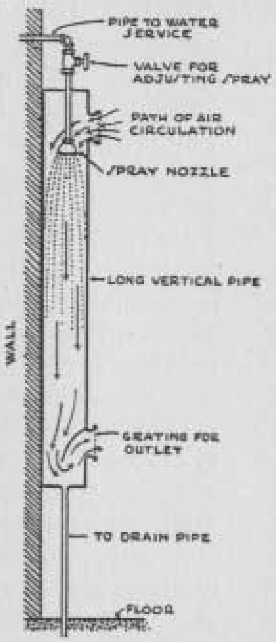



FIGURE 12. SECTION THROUGH SPRAY TYPE HUMIDIFIER



washed as it passes through the spray. The excess water is collected at the lower end of the box and drained away.

## GENERAL REMARKS

The foregoing is only a general indication of the types of humidifiers that are now available. Many new types are being developed and placed on the market from day to day, and the householder would be well advised to obtain full information from the various dealers, particularly as to the quantity of water evaporated by each under normal conditions.

Many householders may be impressed with the desirability and necessity of securing relief from the present dry air conditions in their houses, but only to the extent that that relief can be obtained with humidification-equipment of a simple type requiring no attention involving the apparent inconvenience and difficulty of using a hygrometer.

To these householders it might be emphasized that even a partial relief from dry air conditions is of considerable value in the maintenance of health and the preservation of house and furnishings.

Moreover, it might be again pointed out that humidifiers operated in conjunction with the heating equipment, if of adequate capacity to serve under average heating conditions, require practically no attention except that of maintaining the water supply and of an occasional cleaning—the hot fires required in severe weather evaporating the larger quantities of water then required for ample humidification. Thus the number of water pans installed on the radiators of a house heated by steam or hot water, having the evaporating capacity to give healthful humidification in average winter weather, will, for all practical purposes, give adequate relief from dry air conditions throughout the whole heating season—similarly with the water pans on hot- or warm-air furnaces and with other humidifiers of the same general class.

In conclusion, however, it cannot be too strongly stressed that the adequacy of the humidifying equipment installed in any house can be determined with assurance only by the results in humidification as measured by a hygrometer; and, further, that the most effectual operation of such equipment can be assured only through the use of the same instrument.

# APPENDIX

## HOW TO ASCERTAIN RELATIVE HUMIDITY BY THE USE OF AN ORDINARY HOUSEHOLD THERMOMETER

The wet bulb thermometer is simply an ordinary thermometer, the bulb of which is wrapped with a small piece of cheesecloth or similar fabric saturated with water. The evaporation of water from this wet cheesecloth wrapper lowers the temperature of the air surrounding the bulb by an amount depending upon the rate of evaporation. As the rate of evaporation in turn depends upon the dryness of the air it is clear that the difference between the dry bulb and wet bulb temperatures is a measure of the relative humidity. Tables have been prepared showing the relative humidity expressed in per cent to correspond with varying differences covering a wide range of temperatures.

An ordinary household thermometer can thus be used to measure relative humidity. The thermometer so used should be one which has the bulb freely exposed, or if the bulb is protected should have the metal or wood surrounding it cut away.

The dry bulb temperature is first obtained by reading the thermometer with the bulb uncovered. The bulb is then covered or wrapped with a thin piece of cheesecloth or muslin which is saturated with water of approximately room temperature. The thermo-

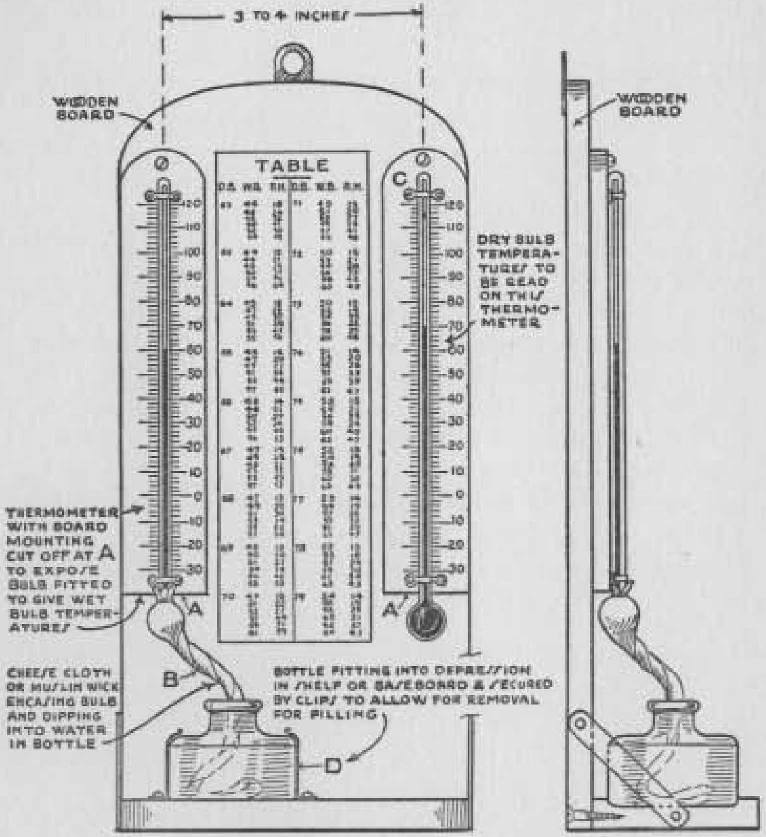



FIGURE 13. HOME MADE HYGROMETER



meter is placed at the point where the dry bulb temperature was obtained and fanned vigorously with a fan or sheet of cardboard for about a minute when the temperature reading is taken. The fanning is continued for a few seconds and the temperature again read. This should be repeated until the lowest possible reading is obtained. The reading so obtained is the wet bulb temperature.

The table on page 35 gives the relative humidities which correspond to the various combinations of dry and wet bulb temperatures that are to be found under average house-heating conditions. Thus if the dry bulb temperature is 70 degrees and the wet bulb is 57 degrees the relative humidity is shown by the table to be 44 per cent.

## A HOME-MADE HYGROMETER

For greater convenience a hygrometer may be made by mounting two thermometers (as sold for household use) side by side about three and one-half inches apart on a board which is fitted to hang from a hook on the wall or with a base which will enable it to stand on a table (Figure 13). Care should be taken in selecting the thermometers to obtain two that give accurate temperature readings at or near the usual room temperatures, or at least that give readings which, while not absolutely accurate, agree over that range. The bulbs should be freely exposed to the air as described in the preceding section by cutting away the enclosing wood or metal where necessary. A small bottle filled with clean water is clipped to the base or to a shelf fitted to the board below the thermometer which is to be used to give wet bulb temperatures. A wick is made of clean cheesecloth or muslin, one end of which is made to encase the bulb and secured to it by a few stitches of thread, the other end dipping into the bottle. Capillary action will then keep the wrapping of the bulb saturated.

Dry and wet bulb temperatures are read immediately after the instrument is fanned until the minimum reading on the wet bulb thermometer is reached. The corresponding relative humidity is then taken from the table on the following page as already explained in the preceding section.



# RELATIVE HUMIDITY TABLE

| D.B.[1] | W.B.[2] | R.H.[3] | D.B.[1] | W.B.[2] | R.H.[3] | D.B.[1] | W.B.[2] | R.H.[3] | D.B.[1] | W.B.[2] | R.H.[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° | % | ° | ° | % | ° | ° | % | ° | ° | % |
| 58...... | 41 | 15 | 64.... | 45 | 15 | 68... | 47 | 13 | 72... | 50 | 15 |
| | 43 | 24 | | 47 | 22 | | 49 | 20 | | 52 | 21 |
| | 45 | 33 | | 49 | 30 | | 51 | 27 | | 54 | 28 |
| | 47 | 42 | | 51 | 38 | | 53 | 34 | | 56 | 34 |
| | 49 | 52 | | 53 | 47 | | 55 | 42 | | 58 | 42 |
| | 51 | 62 | | 55 | 56 | | 57 | 50 | | 60 | 49 |
| | 53 | 72 | | 57 | 65 | | 59 | 58 | | 62 | 57 |
| | | | | | | | 61 | 67 | | 64 | 65 |
| 60...... | 42 | 14 | 65.... | 45 | 12 | 69... | 48 | 13 | 73... | 50 | 13 |
| | 44 | 22 | | 47 | 20 | | 50 | 20 | | 52 | 19 |
| | 46 | 31 | | 49 | 27 | | 52 | 27 | | 54 | 25 |
| | 48 | 40 | | 51 | 35 | | 54 | 34 | | 56 | 32 |
| | 50 | 49 | | 53 | 44 | | 56 | 42 | | 58 | 39 |
| | 52 | 58 | | 55 | 52 | | 58 | 50 | | 60 | 46 |
| | 54 | 68 | | 57 | 61 | | 60 | 58 | | 62 | 53 |
| | | | | | | | 62 | 67 | | 64 | 61 |
| 62...... | 44 | 16 | 66.... | 46 | 14 | 70... | 49 | 15 | 74... | 51 | 14 |
| | 46 | 24 | | 48 | 21 | | 51 | 22 | | 53 | 20 |
| | 48 | 32 | | 50 | 29 | | 53 | 29 | | 55 | 26 |
| | 50 | 41 | | 52 | 36 | | 55 | 36 | | 57 | 33 |
| | 52 | 50 | | 54 | 44 | | 57 | 44 | | 59 | 39 |
| | 54 | 59 | | 56 | 53 | | 59 | 51 | | 61 | 47 |
| | 56 | 69 | | 58 | 61 | | 61 | 59 | | 63 | 54 |
| | | | | | | | 63 | 68 | | 65 | 61 |
| 63...... | 44 | 13 | 67.... | 47 | 15 | 71... | 49 | 13 | 75... | 52 | 15 |
| | 46 | 21 | | 49 | 22 | | 51 | 20 | | 54 | 21 |
| | 48 | 29 | | 51 | 30 | | 53 | 27 | | 56 | 27 |
| | 50 | 37 | | 53 | 37 | | 55 | 33 | | 58 | 34 |
| | 52 | 46 | | 55 | 45 | | 57 | 41 | | 60 | 40 |
| | 54 | 55 | | 57 | 53 | | 59 | 48 | | 62 | 47 |
| | 56 | 64 | | 59 | 62 | | 61 | 56 | | 64 | 54 |
| | | | | | | | 63 | 64 | | 66 | 62 |

[1] D.B.—Dry Bulb Temperature.
[2] W.B.—Wet Bulb Temperature.
[3] R.H.—Corresponding Relative Humidity in per cent.

NOTE.—The above table is prepared for use with a hygrometer of the dry and wet bulb type and covers the range of temperatures and corresponding relative humidities that may be found in house heating.

EXAMPLE.—Dry bulb temperature 68 degrees, wet bulb temperature 55 degrees. The relative humidity is found in the third column=42 per cent.

PASTE ON A SHEET OF CARDBOARD AND KEEP FOR REFERENCE

## SUMMARY

1. "Dry" air is inevitable in houses during the heating season with all present types of heating equipment, unless special provision is made for humidification.

2. "Dry" air is detrimental to health, and has a destructive effect on clothing, furnishings, furniture, and interior woodwork.

3. "Dry" air produces a sensation of cold at normal temperatures owing to excessive evaporation from the skin, and necessitates higher room temperatures for comfort.

4. "Relative humidity" is an expression in percentage of the relation between the moisture actually contained in air at any temperature and the moisture it can contain at that temperature. The lower the relative humidity the stronger is the water absorptive or abstractive power of air.

5. The outdoor relative humidity during the Canadian winter varies from 70 to 100 per cent. The relative humidity of indoor air should be at least 40 per cent for health and comfort but should not greatly exceed 50 per cent on account of the excessive frosting of windows (using double windows) that occurs with high relative humidities.

6. Relative humidities can be accurately determined only by the use of hygrometers or other humidity measuring instruments. The effective control of

humidity conditions in house heating depends therefore upon information which can only be furnished by a hygrometer.

7. The average small house requires the special evaporation of from three or four to twelve or more gallons of water per day during the winter, depending mostly on weather conditions and ventilation. The continual use of the hygrometer is necessary to determine whether sufficient water is being evaporated.

8. Humidifiers or devices for supplying moisture to air are available for use in houses heated by any type of heating equipment. Householders should obtain definite information as to the capacities for evaporating water of the various humidifiers offered for sale before making a selection.

HUMIDITY IN HOUSE HEATING is the second of a series of pamphlets which the Dominion Fuel Board is issuing on house insulation, humidity, and allied subjects.

The first of the series to be issued was WHY YOU SHOULD INSULATE YOUR HOME.

Copies of these pamphlets may be obtained on application to:

The Dominion Fuel Board, Ottawa,

or

The Natural Resources Intelligence Service,
Department of the Interior,
Ottawa.

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