MSVD:BNH

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON

Letter Circular LC-263

November 23, 1924
(Revised April 1, 1929)

Painting of Steam and Hot Water Radiators

For a number of years this subject has received considerable attention from the public, and it is apparent that the essential facts have not always been understood. The object of this note is to supply the more important facts in the case.

We will state at the outset the principal conclusion, which will be explained in more detail later, that repainting a radiator may, under otherwise identical conditions, cause it to transfer either more or less heat into the room than before, so that the effect of repainting would be the same as of putting in a different radiator, either larger or smaller as the case may be.

The purpose of a heating system is to maintain the rooms in a house at some temperature higher than that prevailing out of doors. The heat which is developed by burning fuel is transferred to the rooms by means of the radiators. A radiator neither creates nor destroys heat, and a large radiator, while it can put more heat into a room than a small one, must be supplied with all of the heat it puts in. In the sense that they ultimately transfer all the heat supplied into the room, all radiators are 100% efficient. The word "efficiency" is, however, used in other ways, and it is now customary to use it on all possible occasions, but it is hardly correct to say that putting metallic paint on a radiator reduces its efficiency when the effect is merely to reduce its capacity. The size of the radiators in a house is only remotely connected with the amount of fuel required for heating, and unless the radiators were so small as to make the whole heating plant ineffective, no noticeable saving of fuel would be expected to result from installing larger radiators.

It will appear that as far as their effect on the performance of radiators is concerned, paints fall into two classes; first, those in which the pigment consists of small flakes of metal, such as the aluminum and bronze paints, most commonly used for painting radiators, which produce a metallic appearance and will be called metallic paints; second, the white and colored paints, in which the pigment consists, not of the metals but of oxides or other compounds of the metals. Thus white lead paints, or those containing compounds of zinc or

other metals, will be called non-metallic paints. These non-metallic paints are obtainable in practically all colors, including white and black, while the metallic paints have the color of the metal or alloy of which the flakes are composed.

After these preliminary explanations, we may proceed to consider what kind of effects may be obtained by the use of various kinds of paint. The heat emitted from a radiator is removed in two ways: first, the air streaming past the radiator and rising from it is heated, and carries the heat to other parts of the room; second, the hot surface of the radiator emits heat by radiation just as the glowing electric and gas heaters do. Most types of steam and hot water "radiators" emit less than half their heat by radiation, and evidently the name "radiator" although universally used, is not a particularly appropriate one.

To take a concrete case, a particular sectional cast iron radiator if painted with any non-metallic paint might transfer into the room, 180 Btu. per hour for each square foot of its surface, if supplied with the necessary amount of heat from a boiler. (A British Thermal Unit or Btu is the amount of heat required to raise the temperature of one pound of water by 1°F.) The burning of one pound of good coal produces about 12000 Btu and if the coal is used in a domestic heating plant, perhaps half of this, or 6000 Btu might finally be transferred from the radiators into the rooms. Most of the other half of the heat produced is inevitably lost via the chimney.

The area of one section of a cast iron radiator is about 2 square feet for the smaller sections and up to 7 or 8 square feet for the larger sections so that a 10 section radiator would have a surface area between 20 and 80 square feet.

Of the 180 Btu per hour transferred, about 2/3 or 120 Btu would go to heating the air which passes over the radiator. The 120 Btu transferred directly to the air would not be increased or decreased by repainting the radiator. The remaining 60 Btu not carried off by the air is emitted as radiant energy. The amount of radiant energy which can be emitted per hour by the hot surface is dependent upon the kind of paint used for the last coat. It was assumed that the radiator was painted with non-metallic paint. If it be repainted with a metallic paint, such as aluminum or bronze, it will no longer be able to radiate 60 Btu per hour, but may be able to radiate only 30 Btu, so that instead of transferring 180 Btu to the room per hour, it can now transfer only 150 Btu. The coat of aluminum or bronze paint is not an insulating covering like a covering of magnesia or asbestos, but it has a similar effect, although for an entirely different reason.

The resulting reduction in heat emission is entirely due to the reduction in the radiating power of the exposed surface, rather than to the insignificant insulating value of the thin layer of paint. It is therefore evident that undercoats of paint, regardless of kind, have no significant effect on the performance of the radiator, except in the practically impossible case where the paint was thick enough to act as an insulating covering. In repainting a radiator, it is therefore unnecessary to remove the old paint. The effect of adding the metallic paint is equivalent to removing 1/6 of the radiator, or nearly 17%, or as if one section out of six had been removed. Thus a radiator of five sections painted with white or colored paint should be about as effective as another of six sections of the same kind, painted with metallic paint, since each would transfer the same amount of heat to the room, provided the necessary amount of heat were supplied to each.

In the following applications, the numerical values given above will be used as if they were exact, but it must be understood that they are merely representative and would not apply exactly to any particular case except by chance. The effect of painting on the capacity of a radiator depends upon the size and design of the radiator. The reduction in capacity produced by the application of aluminum paint is less for large radiators than for small ones, especially so in the case of large radiators having many columns or tubes per section. In a large tubular type radiator having 7 tubes per section, more than 3/4 of the heat is carried away by the air directly, and painting with aluminum consequently reduces the capacity of the radiator only about 10% If only the visible portions of a radiator are painted with aluminum paint, the reduction in capacity is also obviously less than if the entire surface is covered.

Application 1. Suppose a house in which all the radiators are painted with aluminum paint, and that the radiator in one room is found to be too small, so that when the other rooms are warm enough, this one is too cold. If the radiator in this room is repainted with non-metallic paint either white or colored, the heat emitted by it can be increased from 10 to 20% without affecting conditions in the other rooms, although it will be necessary to burn more fuel to supply the additional heat in the one room. If the increase is sufficient the expense of installing a larger radiator may thus be avoided.

Similarly, it is possible, by using bronze or aluminum paint on radiators in rooms which are overheated, and colored or white paints in rooms not sufficiently heated, to improve conditions without going to the expense of installing new radiators of larger or smaller sizes.

Application 2. In installing radiators in a new house, somewhat smaller radiators may be installed if they are to be painted with colored paints, rather than bronze or aluminum paints.

Application 3. If the radiators on a hot water system are painted with metallic paint, and are all too small, so that the water must be kept hotter than is desired in order to heat the house, they may be repainted with non-metallic paint, and it should then be possible to heat the house with the water in the system not quite so hot. There will be no noticeable saving of fuel.

Application 4. Since basements are usually overheated so that much of the heat supplied there is wasted, some economy can be affected by painting the heater and pipes with metallic paint. This can not, however, serve as anything more than a poor substitute for a covering of good insulating material, about an inch thick, which is capable of making an appreciable saving in the coal bill. The insulating material will remain effective for years, while the paint becomes ineffective if covered with dust.

Application 5. If a radiator is situated next to an outside wall, as most of them are, it is evident that the heat supplied directly to this wall is more or less wasted. Some slight economy may be obtained, therefore, by using metallic paint on the side facing the wall and non-metallic paint on the visible portions. The gain is not large enough to be important, but on the other hand, in putting non-metallic paint over metallic, it is not worth while to go to the trouble of repainting the side next the wall.

Results of emissive tests of paints for decreasing or increasing heat radiation from surfaces, and a discussion of various applications of the results found, are given in Bureau of Standards Technologic Paper No. 254, which may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., at five cents per copy.