TECH TIP # 47

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

Determining Equivalent Round/Rectangular Ducts

Since both round and rectangular ducts are used in air conditioning distribution systems, it is quite possible that a contractor may wish to substitute one for the other while working on new construction or modifying an existing system. With this likelihood it's well to fully understand the conditions under which round and rectangular pipe can be interchanged. That is: understand exactly what is meant by the expression circular equivalent of a rectangular duct.

RELATE AREA TO PERIMETER FOR TRUE SIMILITUDE

In modern text books written on fluid mechanics the term hydraulic radius is used to successfully express the characteristic size of a duct as it relates to pressure loss.

The hydraulic radius is defined as the cross-sectional area of the duct divided by the wetted perimeter (actual surface covered by fluid). In the case of air flow in ducts, the wetter perimeter is equal to the full perimeter of the duct.

More frequently, the term is expressed as a diameter, rather than a radius, so the hydraulic diameter is equal to:

$$D = 4A/P$$

where D = hydraulic diameter
A = cross-sectional area of duct
P = perimeter of duct.

In terms of a rectangular duct, the hydraulic diameter can be expressed as follows:

$$D = 2(dw)/(d+w)$$

where "d" is the depth of the duct and "w" is the width. For a round duct the hydraulic diameter conveniently turns out to be equal to its actual physical diameter.

Now, ducts having the same length, the same air velocity inside and the same hydraulic diameters will experience the same pressure loss. Hence, this last relationship expresses the circular equivalent of a rectangular duct under the condition of equal air velocity in each. Figure 1 (on page 3) is a graph of the expression for a range of duct depths and widths.

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MORE OFTEN EQUAL CAPACITY IS REQUIRED

The relationship between round and rectangular ducts for equal pressure loss under the condition of equal capacity in each is more complex. But it is possible to take fundamental friction loss relationships, make appropriate substitutes for duct areas, hydraulic diameters, etc. and arrive at the following expression:

$$D = 1.3\ (dw)^{0.625}/(d+w)^{0.25}$$

Figure 2 (on page 3) is a representation of this expression for a range of duct sizes.

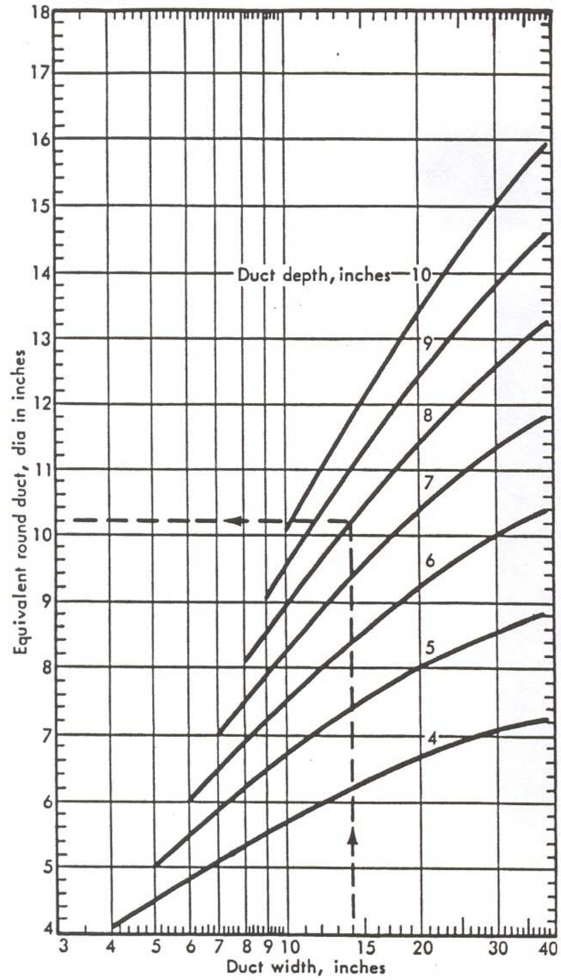
From the charts, or by direct substitution in the equations we can see that an 8 x 14 inch duct, for example, is equivalent to a 10.2 inch round under the condition of equal velocity, but the same 8 x 14 inch duct can replace a much larger 11.5 inch round under the condition of equal capacity for the same pressure loss.

THE NEED TO SUBSTITUTE

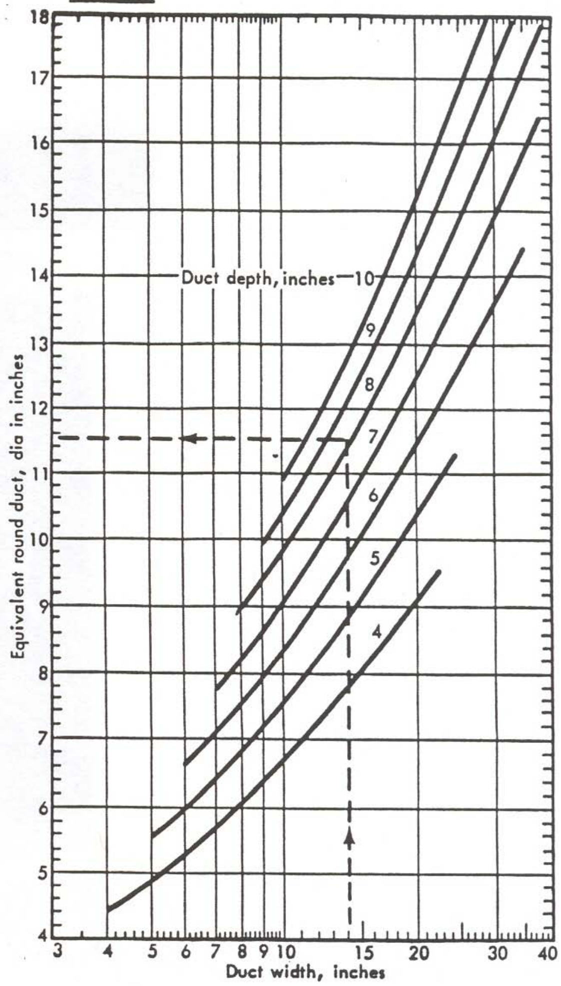
Some contractors try to avoid using round duct; others suggest it as the most economical way to do a job. In terms of sheet metal, a round duct is obviously the most efficient. For instance: the circumference of the 11.5 inch round is only 36 inches compared to 44 inches for its rectangular counterpart for equal capacity. Roughly speaking then, the 11.5 inch round should use 18 percent less metal.

Oil canning is no problem with round pipe either. But, the rectangular duct can provide more headroom when needed (almost 4 inches more in our present example), and it can carry the same air quantity at a lower velocity, thus possibly providing a quieter arrangement. But whatever the choice, the two charts just presented should be helpful in simplifying design changes.

1 Circular equivalent of rectangular duct for **equal** velocity



2 Circular equivalent of rectangular duct for equal **capacity**



To find the circular equivalent of a specific rectangular duct, use the chart at left to obtain equal pressure loss with equal velocity; the chart on right to obtain pressure loss with equal capacity. One way to use the charts is to enter base scale at value corresponding to the width of duct, say 14 inches (follow broken lines in either chart). Move up until line corresponding to duct depth is reached (8 inches in our example). Then, move left, horizontally, and read at left, 11.5 inches from chart 2 on right. Charts can also be used "in reverse." That is: find the rectangular equivalent of a specific round pipe. In this case, start on vertical scale; move right to intersect curve for duct depth; then read required duct width on base scale.