PERFORMANCE OF LOW WATTAGE FANS & SMALL PIPE SIZES WITH ASD SYSTEMS

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ABSTRACT

Radon mitigators often use radon fans that are much larger capacity than is needed. This paper reviews the performance of about 180 radon mitigation systems that were installed using a low wattage (14 - 20 watt) radon fan. The paper also reviews the use of PVC piping that is smaller than three inch and its performance as compared to using standard piping with dampers to control the airflow.

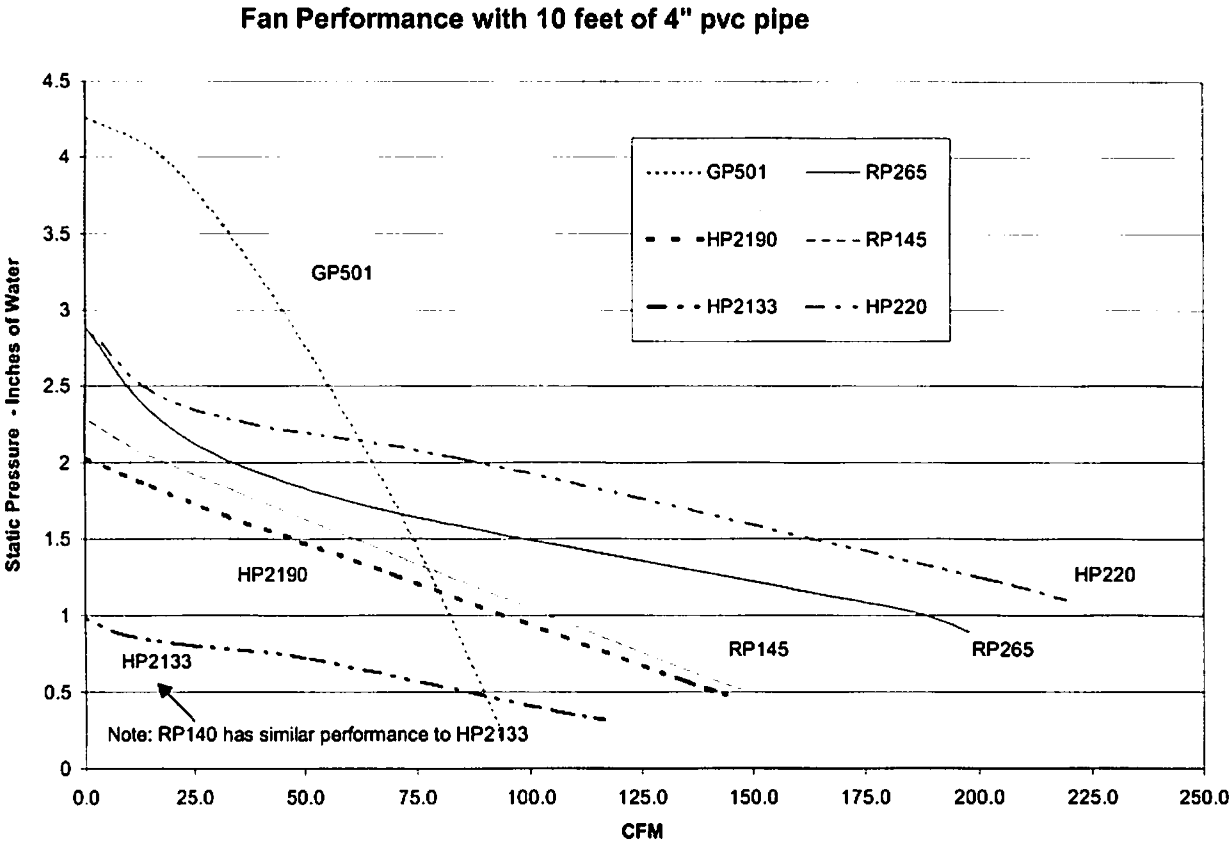
INTRODUCTION

Many mitigators tend to use one particular radon fan for almost all of their mitigation installations without considerations of optimizing the fan for the particular situation. In fact a predominate number of mitigation jobs could be remedied using any available radon fan if proper slab sealing is done. The author over the last 18 months utilized the smallest available radon fan to successful mitigate over one third of the jobs that were contracted with his company. The following graphs demonstrate the success of this approach. There are a number of reasons why the use of a small fan is warranted.

It is often advantageous in a multi-suction radon mitigation system to reduce the airflow from one of the suction holes in order to minimize its effect on the remaining suction holes. Some mitigators prefer to use smaller piping to accomplish this while other mitigators will install a damper in the piping to control the flow. The difference in airflow was compared using different pipe sizes versus installing a damper.

FAN CHARACTRISICS

The first graph gives a comparison of some common radon fans. The fan performance data was obtained by placing five feet of four inch pvc piping on both the intake and the exhaust ports of each fan and then changing the restriction on the intake port while measuring the static pressure and the airflow. The airflow was measured using an inline flow grid pitot tube connected to a digital micro-manometer. The static pressure was measured with a second digital micro-manometer that was connected to the reference port of a pitot tube inserted in the piping on the restriction side of the fan. This graph was presented in a paper at a previous AARST annual symposium conference. The graph illustrates the variation in maximum fan induced vacuum from about 0.8 to 4.0 inches of static water column. The maximum air flow of these fans ranged from about 90 cfm to 225 cfm with 10 feet of 4 inch pvc piping. The primary fan used by WPB in this study was the RP145. This fan has a performance curve that is in the middle of the group with a maximum vacuum of just over 2.0 inches of static pressure and a maximum airflow of 150 cfm. The comparison fan in the study is the HP2133 and RP140. These fans are sold by different radon fan manufacturing companies using different housings but a similar motor. The fan performance of the RP140 although not included in this graph was assumed to be similar to the HP2133. The HP2133 and the RP140 fan have a maximum vacuum of 0.8 to 0.9 inches of vacuum and a maximum airflow through ten feet of open four inch pvc pipe of about 120 cfm.



ELECTRICAL COSTS

The wattage of the RP140 and HP2133 is approximately one third of the RP145. Note that in the graphs below the wattage is a range. The wattage decreases as the airflow is reduced by increasing system static pressure. In other words when the common system indicator, a u-tube, is showing a large difference in the oil columns, the airflow is low and the system electrical consumption is actually less. To compare the difference between the fans we might use a mid-wattage consumption of 17 watts for the smaller fans and 54 watts for the RP145. If you calculate the electrical cost per year using an average electrical rate of 12 cents per kilo-watt hour it equals $17.87 for the RP140/HP2133 and $56.77 for the RP145 per year.

(Hours) X (Wattage) ÷ (1000) X (Kilo-watt per hour rate) = Electrical Operating Cost

For comparison sake the RP265/HP220/GP501 fans, which have a range of 70 to 140 watts, would cost an average of about $118.79 per year. If you used an average length of home ownership of ten years, the radon system electrical cost over that period would be $178.70 for the RP140/HP2133, $567.70 for the RP145 and $1187.90 for the RP265/HP220/GP501. This last fan group would actually cost more to operate over ten years than the installation cost of a majority of the mitigation installations in our area.

FAN NOISE

There are a number of other factors to consider in choosing a radon fan. Customers will occasionally complain that the system is audible in the living areas to the point of being annoying. The noise can be from different conditions. The source of the noise can be the fan, the airflow through the pipe or vibration transfer to building components. Radon piping installed by a mitigator or the builder during the house construction can occasionally turn into a call back because of system noise caused by vibration transfer from three inch pvc radon piping squeezed into a three and half inch stud wall. A vibration transfer through the drywall will be especially upsetting to a homeowner if the builder routed the radon through the master bedroom walls. The low wattage fans would be a good choice in this case because they produce considerably less vibration than the larger fans. It is actually often difficult to determine if these low wattage fans are even operating unless you are immediately adjacent to the fan.

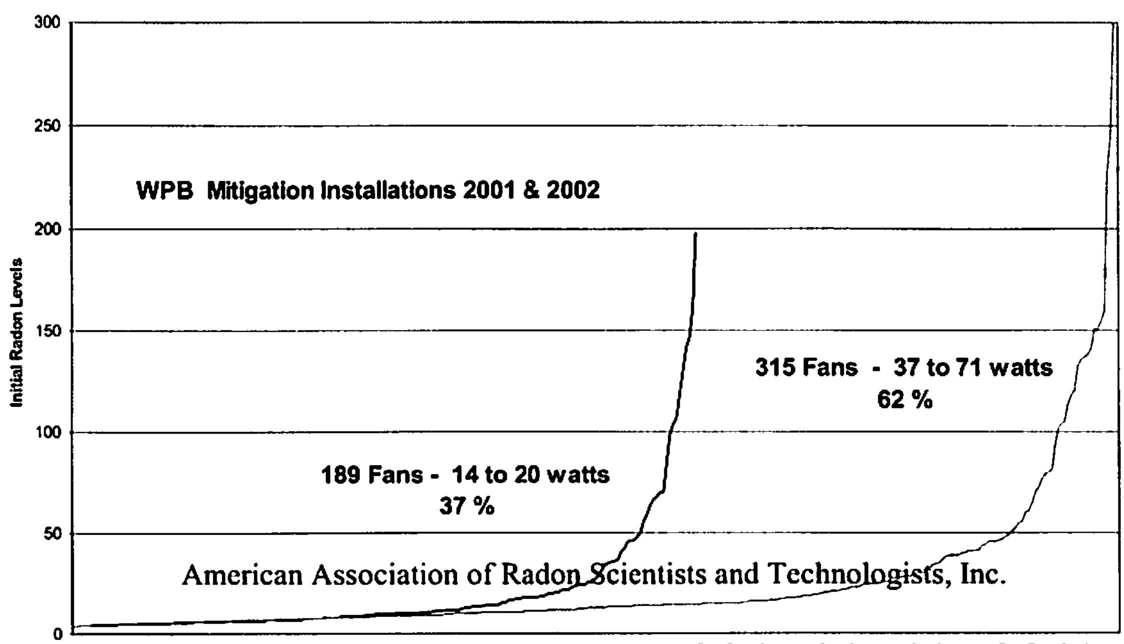
FAN FAILURE

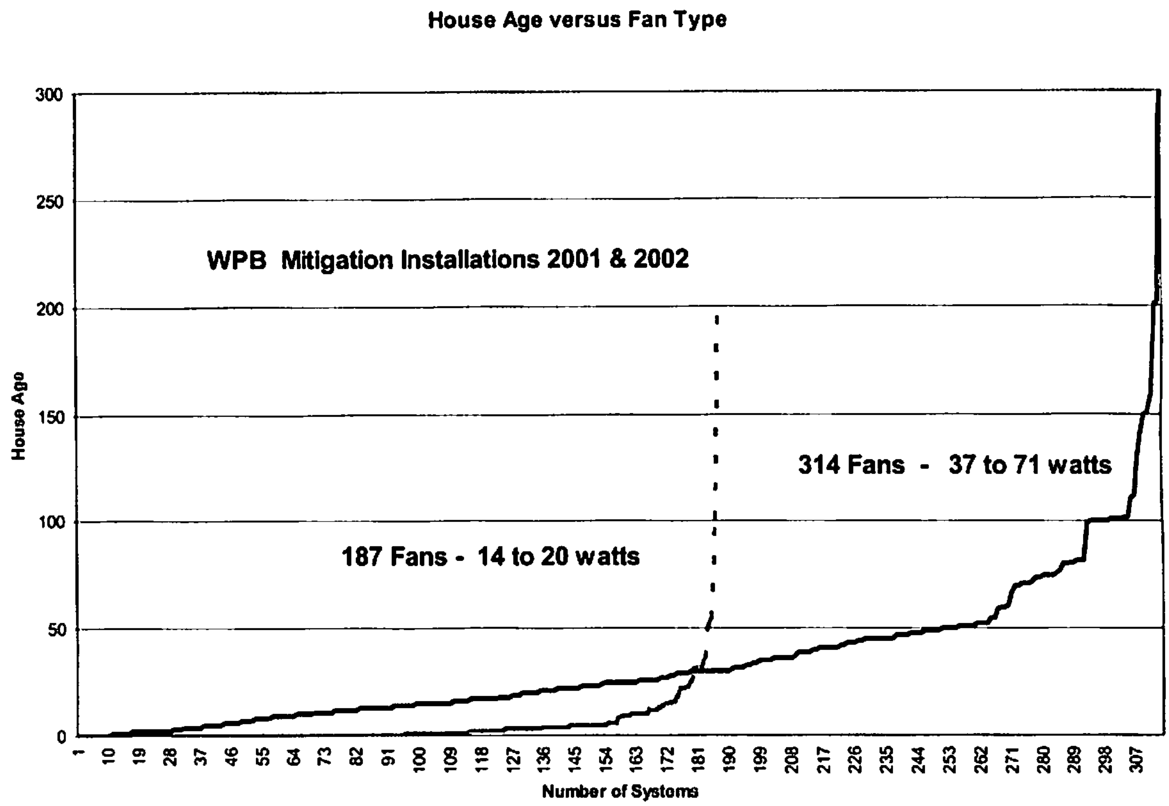
The low wattage fans run considerably cooler than the RP145 and larger fans. This should translate into a longer lasting fan with fewer call backs for repairs. Of the 315 RP145 fans installed in 2001 and 2002 we had 14 (4.4%) that went bad and required replacement. Although these fans were under warranty it still required a service call, office time to package them up and shipping costs to obtain a replacement fan. This is easily one to two hours of total labor cost plus shipping which adds up to total cost of $500 to $1000. There was an initial series of 8 bad HP2133 fans out of the 90 (8.9%) that went bad but it appeared it was only from an early shipmen of defective fans. There was however no failures with the 95 RP140s fans that have been put in service.

FAN USAGE AND PERFORMANCE

The initial radon levels in the building did not play a part in the selection of low wattage fans as shown in the comparison graph below. The age of the house did however influence the fan selection. Newer homes in our area are more likely to have a porous sub-slab aggregate layer or even sub-slab perforated piping. This typically allows a single suction location to easily produce a strong sub-slab negative pressure under the whole slab after all the open cracks have been sealed even if a low wattage fan is used. The use of a single suction point is typically still successful even though the homes being currently built much larger than older homes.

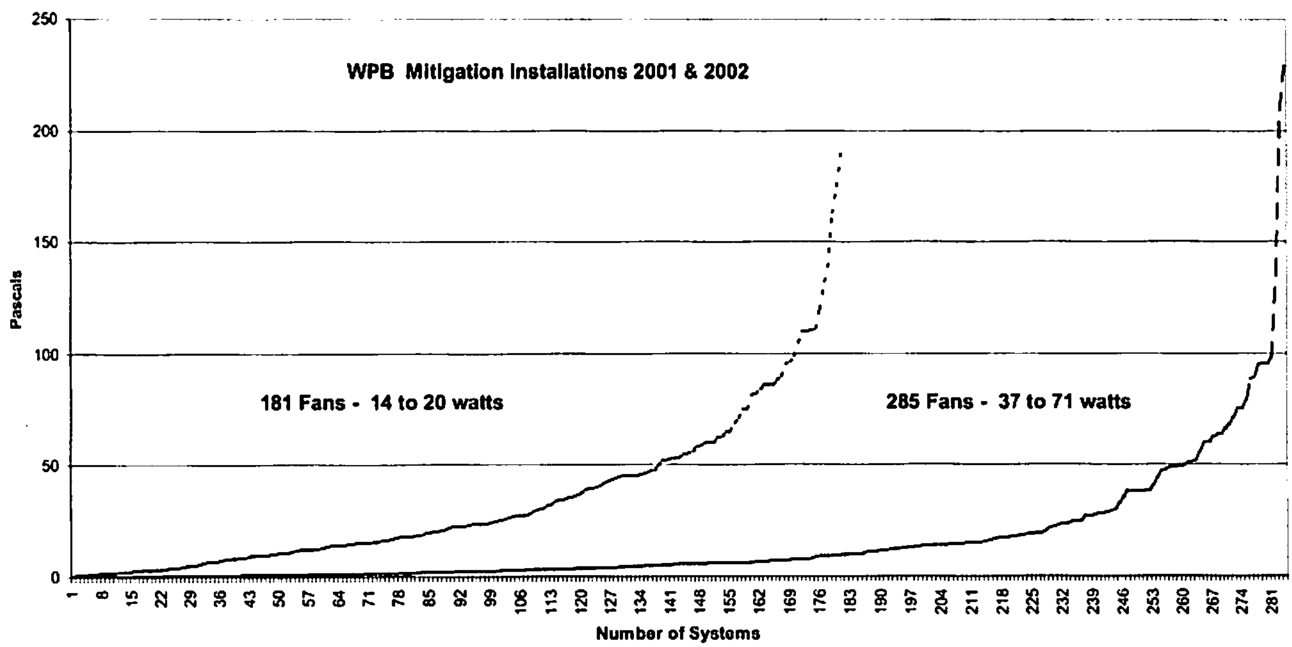
Initial Radon Levels



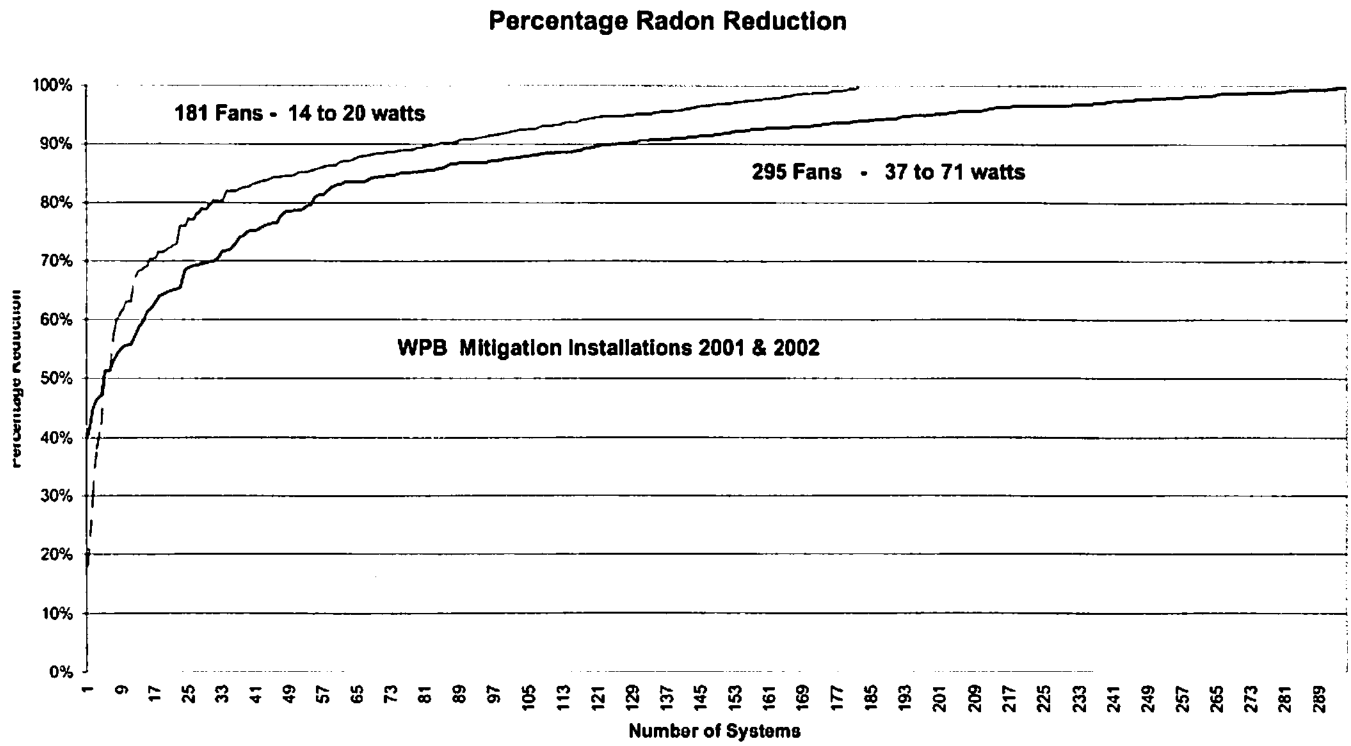


The sub-slab communication performance actually has more to do with how well the openings and cracks in the slab can be sealed rather than the fan size. Our company policy is to seal all visible cracks that are large enough to get your fingernail into. Sealing dramatically improves the pressure field extension strength. It is not unusual to see the sub-slab negative pressure reading increase by a factor of ten or more after sealing cracks. In the graph below the final sub-slab to basement pressure readings are graphed. Note that the low wattage radon fans actually had greater percentage of systems with higher sub-slab vacuum than the RP145 fan. This is due to the predominate use of the low wattage fans for new homes. Older homes tend to be more likely to have no aggregate under the slab and weaker final sub-slab vacuum measurements.

Final Sub-Slab Pressure

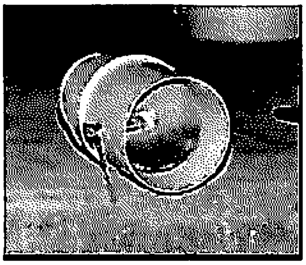


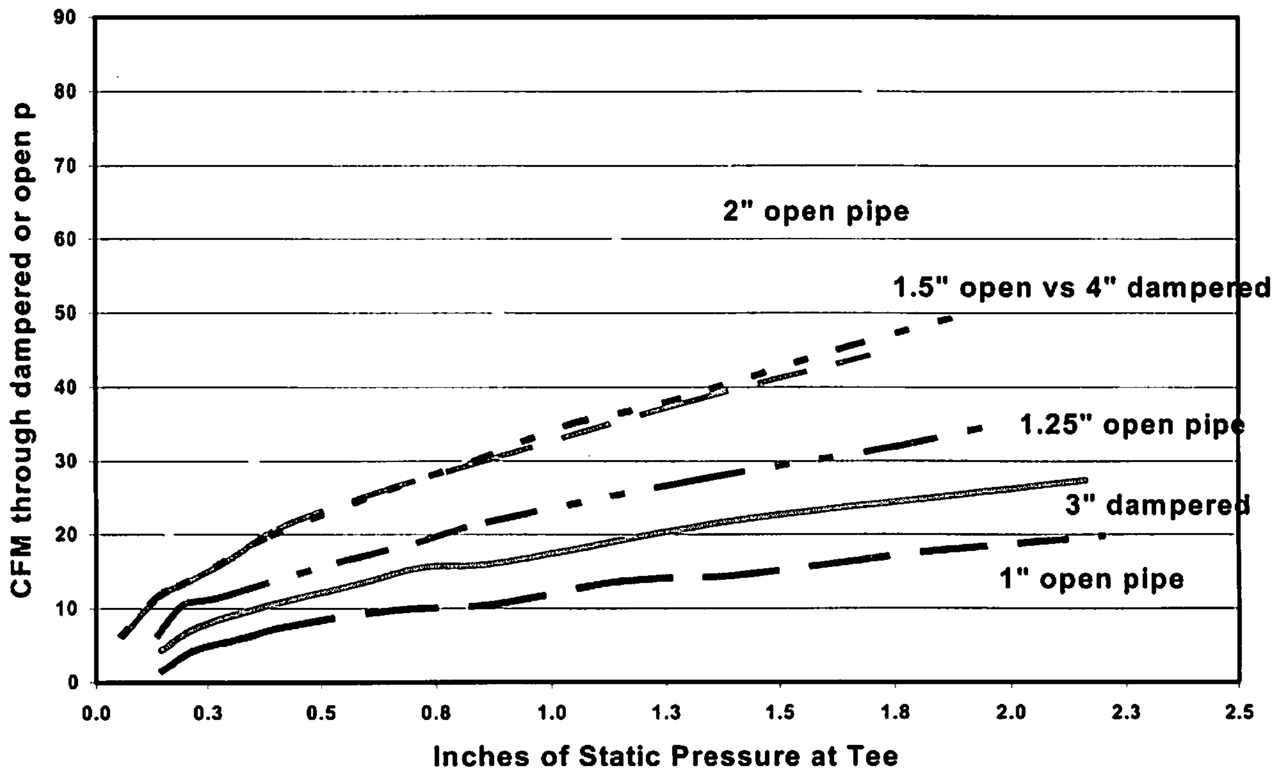
The final percentage radon reduction was actually higher for the low wattage fans than the RP145 fans. This was most likely due to use of the RP145 with more difficult buildings. Even considering this it is obvious that the low wattage fans are more than capable of reducing the radon levels in a significant number of mitigation installations.



REDUCING SYSTEM AIRFLOW IN INDIVIDUAL SYSTEM SUCTION LOCATIONS

In radon multi-suction systems the performance of individual suction locations can be significantly reduced if one or more suction locations is allowing a large airflow. Suction holes located after a high airflow suction hole will especially have significantly reduced performance. Often this high airflow suction location does not require the amount of airflow the system is capable of extracting in order to be effective. It may also be the case that the more significant radon source is from the low flow suction location and not from the large flow location. An example of this would be an older home with a small dirt floor crawl space with hollow block walls and a basement slab without sub-slab aggregate. The basement slab will typically be a low flow situation requiring a high static pressure to over come the resistance of the sub-slab soil. The crawl space will tend to be a large flow situation because of the porous conditions of the block wall that is exposed under the crawl space membrane. If the crawl space soil barrier can however be reasonably sealed it will not require a wide open radon pipe to maintain a negative condition under the membrane. The last graph shows the amount of airflow through reduced sized pvc piping and different damper usages. The amount of airflow past the damper or through different sized pipe is related to the negative pressure in the main trunk piping adjacent to the damper or smaller pipe size. The comparison of different dampers and piping size was made using a single fan that was attached to four inch pvc piping that had a tee fitting installed. Varying sized pipe and damper arrangements were attached to the side port of the tee fitting. The static pressure just ahead of the tee on the fan side was measured along with the cfm airflow coming through the dampered pipe or four feet of reduced pipe size along with one 90 degree elbow. The static pressure in front of the tee fitting was varied by restricting the airflow in the far side of the tee away from the fan. This data was then graphed. The graph below gives the approximate cfm air flow that can be expected through dampered or reduced size piping at varying static pressures. In other words a two inch pvc pipe will allow from 10 cfm to 80 cfm of airflow depending on whether the fan is creating a static pressure of 0.1 inches to 2.0 inches of water column in the main pipe trunk close to the damper or reduced pipe size..





Note that an ordinary four inch metal damper has the same air flow as an 1.5" pvc pipe. Four inch metal dampers are actually about 3.75 inches in diameter and even when fully closed allow over 30 cfm of airflow if there is an inch of static pressure in the tee fitting or piping above the damper. Note that the three inch damper was considerable tighter. This was actually due to the fact that the three inch damper was made by cutting down a four inch damper to 3 7/8 inches which is a closer fit than the four inch damper. A common mistake that mitigators make is to use reduced piping that is either too big such as using a 2" pvc pipe with a high system static pressure or expecting a large airflow through a pvc pipe with a small diameter pvc pipe. Some mitigators have used one inch pvc piping to draw air from under a membrane or into a block wall. If there is one inch of static pressure in the pipe a one inch pipe will only allow 10 cfm of air flow. In another situation a mitigator might try installing a jumper pipe from the slab to the block wall or around a solid filled column in a block wall. In these cases the initial static pressure will typically be low. Using a one inch pipe would appear to only allow a few cfm of air flow while a two inch pvc pipe might allow ten cfm or more of air flow.

CONCLUSION

Low wattage radon fans should be a standard component for most mitigators. This fan is especially suited for new construction usage and homes that have sub-slab aggregate and a tight slab or where leakage through the slab can be sealed.

Reducing airflow to single or multiple suction holes can be effectively accomplished with either inline dampers or reduced pipe size. The final cfm airflow is very dependent upon the static pressure in the system piping adjacent to the dampered or reduced size piping. Inline dampers offer the advantage of being able to adjust the airflow after they have been installed.