Re: Efficient use of Air conditioner

Source: http://sci.tech−archive.net/Archive/sci.physics/2004−08/0443.html

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From: The Ghost In The Machine (*ewill_at_aurigae.athghost7038suus.net*)
Date: 08/01/04

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Date: Sun, 01 Aug 2004 16:01:33 GMT
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In sci.physics, ~^Johnny^~
<nospam@gyrogearloose.com>
 wrote
on Sat, 31 Jul 2004 20:40:07 −0700
<m4pog013sf422q634hm8t4mcvaobgrdeau@4ax.com>:
> On Thu, 22 Jul 2004 05:26:53 GMT, bruce@nospam.com (Bruce) wrote:
>
>>In sci.physics
>>jmfbahciv@aol.com wrote:
>>
>>>The best use of a house A/C is to use it with a fan. Nobody
>>>believes me when I say that I cool my house with a 5000 BTU
>>>A/C and two fans.
>>
>>I believe you if you tell me you live in an ice chest.
>
>
> I live in a 600 sq ft cottage. I also live in a mild climate, but I run a
> lot of electronic stuff. Add 80000 BTU/hr for that.
>
> Bottom line, my calculations for cooling come out to 22,000 BTU/hr.
>
> Take off my 8,000, and you still need 14,000. That's for a 600 sq ft cottage
> in Northern California, on the coast (literally). Ten miles from the beach!
>
> 5000 BTU/hr?
>
> I love geek chicks (I am married to one), but, respectfully: NO WAY!
>
> Sorry, bah.

Hmph. Metrically challenged. :−P

But lessee.

600 ft^2 = 55.75 m^2

Assuming your ceilings average 2.5m (my ceilings are 94" = 2.39m,
but there are issues such as entryways and high ceilings), one
gets a total volume of 139.38 m^3.

A computer runs typically 300W, maybe 400W nowadays. (I'm not
entirely certain if the rating on the power supply is the
consumption from the wallsocket or the production at the
motherboard/device level.) 400W translates to 1.44 megaJoules/hr.

5000 BTU = 5.27529726 megaJoules, according to Google.
5000 BTU/hr = 1465 W.

An interesting computation is to take a single 100W light bulb
and place it in a room which is sealed (in the thermal sense).
Assuming your dimensions above, a pressure of 101350 Pascal,
a standard air composition of 29 grams/mole, a room temperature
of 20 C = 293 K, and 1 degree C per kg−cal (which probably isn't
quite right, as this is for liquid water, not air) or 4180 J per kg−K,
and doing a bit of other hand−waving approximation (heated
air expands, for example), one gets

n = PV/(RT) = 101350 * 139.38 / (8.314472 * 293)
  = 5798.58 moles or 168.2 kg.

and then one gets

702.9 kiloJoules per degree C temperature rise.

100 W = 360 kiloJoules per hour.

Not exactly the World's Best Heater, is it? :−) It would take
almost 2 hours to increase the temperature in the domicile by
1 degree Celsius with that light bulb. Therefore, there's a
bit of slop available here.

Even with a good 1800 W heater it would take almost
7 minutes to raise the temperature of your air 1 degree C.

I'd be more worried about the insolation −− which is
1,350 W/m^2. Since we've established you have 55.75 m^2
of roof area, and can compute that you have, according
to my figures, at least approximately four 25 m * 2.5
m = 62.5 m^2 walls, or 250 m^2 of walls, of which half
might be illuminated at any one time (there are a *lot*
of issues here, though, as the tilted sun will be looking
at something generally hexagonal, and you're probably not
living in a big box anyway, but a bunch of smaller ones,
with corridors :−); however, the sunlight also reflects
off the ground onto your housewalls), yielding at the very
most an additional heat load of 244 kW, and probably less
than that, depending on what color your exterior walls

and roof are. That'll heat up the air in a hurry: 35 seconds
per degree C temperature rise.

It gets weirder if one factors in the heat retentitivity of
the walls as well. Air isn't the only thing that heats up.
Also, the heat leaks through the walls (either direction),
which is one reason people like high R−factor insulation
in colder climes (and should in warmer climes, too).

So as the air in the home heats up, the heat will leak out, too
(it's not nearly as sealed as a hypothetical thermodynamic system!)
back to the ambient −− although admittedly the ambient air
is also heating up because of good old Sol.

I'd need more data −− average temperature swings in your area
and all that −− before I can make a more detailed computation,
assuming I'm even close to right here; I'd have to look at
the thermal characteristics of nitrogen, for instance, to make
a more accurate determination of how fast the air will heat up.

http://www.webelements.com/webelements/elements/text/N/thdyn.html

gives me no less than five constants for N2 gas, in rather
inconvenient but workable units (1 mole N2 = 28 grams;
however, our atmosphere consists of very roughly a mixture
of 4 parts nitrogen, 1 part oxygen, and a smidge of argon,
which is why I used 29 grams/mole earlier).

And of course there's probably a good HVAC estimator somewhere
on the Web anyway. :−) An interesting side issue: there is
an old unit of "1 ton" of air conditioning. Apparently the
basis was the cooling capability of 1 ton of ice, but the
standard conversion is now about 1 ton = 12,000 BTU/hr, although
I'm not entirely sure.

[.sigsnip]

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−−
#191, ewill3@earthlink.net
It's still legal to go .sigless.
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