How effective are window tints in cooling our cars?

Update (Dec. 11, 2013): I wrote a series of two articles on the science of car window films:

- Part 1 discusses why our car cabin warms up so rapidly and what methods we can use to cool the car cabin temperature.
- Part 2 discusses how window films work and how to choose the right window film for our cars in Malaysia.

I recently had to replace my car's front windshield which also meant I had to re-tint my windshield. I was curious exactly how effective are car tints in cooling our cars.

Yes, we know tints make our car cooler, but exactly by how much? If car tints are effective, why is it that some people curiously complain that their car tints, even reputable and expensive tints, do not "seem to work"? And my final burning question was: which side of our car windows allow in the most heat? Intuitively, the most critical car window should be the largest window piece which is the front windshield. The larger the window piece, the more the area is exposed to the sun, which in turn meant increasingly more heat would be let in. The manager from a car tint shop I asked confirmed this rationalization – but again, *where is the evidence*?

How hot can it get inside the car? How effective are tints anyway? (photo from images.quickblogcast.com)

But before I discuss about the effectiveness of car tints, I like to highlight that the colour of your car can make a significant impact on your car cabin temperature. In 2005, the TV show Mythbusters (Episode 38) measured the car cabin temperature of two exact car models, differing only in their colours: one was white and another black. These two cars were parked under the hot sun, and car cabin thermometers revealed that the black car was hotter than the white car by as much as 5 degrees Celsius.

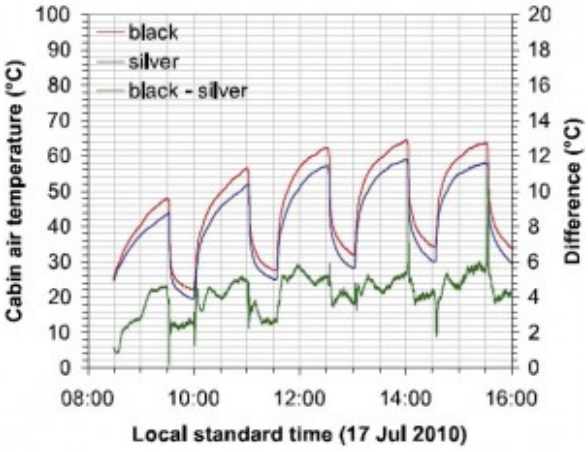
Choose a white car. Mythbusters, a popular TV programme, showed that black cars can be hotter than white cars by as much as 5 degrees Celsius (photo from mythbusters.com).

A scientifically more rigorous experiment in 2011 by Levinson and associates

confirmed that car colours do matter in terms of the amount of heat they let in. The difference in car cabin temperature between a black car and a silver car (same exact Honda car models) ranged between about 0.5 to 10.5 degrees Celsius, with an average between 4 to 5 degrees Celsius.

A black vs. silver car: which car is warmer? (photo from Levinson et al., 2011).

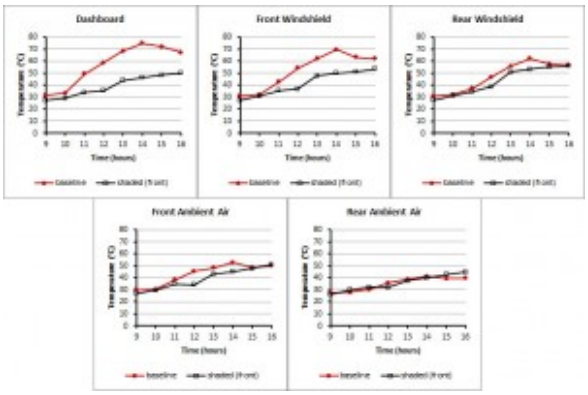
What these two works summarize is that even without tinting your car windows, you can reduce your car cabin temperature significantly, possibly by as much as 10 degrees Celsius, simply by choosing a lighter over a darker coloured car.



Levinson and associates confirmed that darker coloured cars are warmer than lighter coloured cars. Shown here are car cabin temperature fluctuations during heating (car aircon off) and cooling (car aircon on) cycles for a black and a silver car. “Black-silver” denotes the difference between the

temperature of black and silver car (from Levinson et al., 2011).

Our car cabin does not warm uniformly. In a typical hot day in Malaysia, the dashboard can reach a scorching 80 degrees Celsius, the front windshield 70 degrees Celsius, and the interior ambient air 50 degrees Celsius.

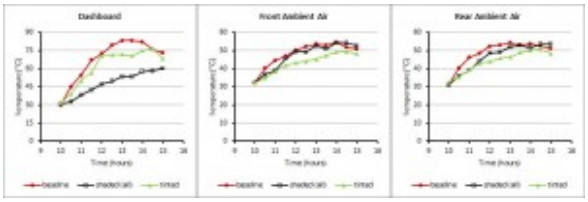


Car cabin does not warm uniformly, where the dashboard experiences the highest warming. Sunshade (placed behind the front windshield) lowered the temperature of the dashboard and front ambient air, but the sunshade had a less cooling effect on the rear windshield and rear ambient air (redrawn from Al-Kayiem et al., 2010).

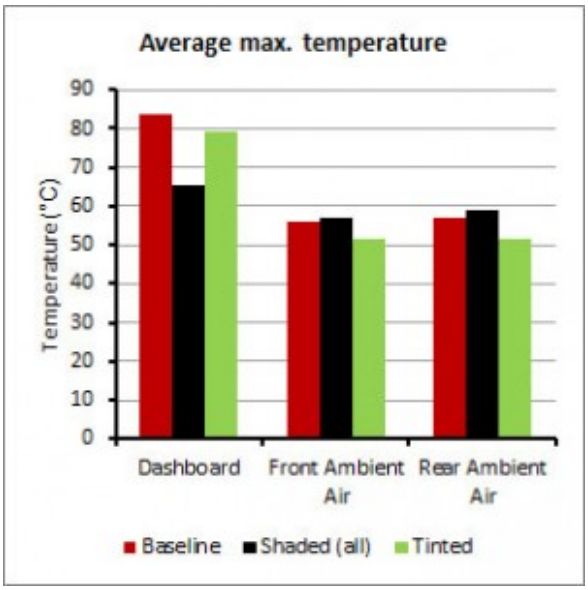
Al-Kayiem and associates in 2010 found that using a reflective sunshade on the front windshield could reduce the dashboard and front windshield temperature by as much as 30 and 20 degrees Celsius, respectively. The front-placed sunshade could also cool the front ambient cabin air by as much as 10 degrees Celsius. Nevertheless, given enough time, the car cabin temperature under the protection of a sunshade would eventually reach the same heat levels as that without a sunshade protection. Without sun protection from the rear, a sunshade placed only in the front of the car had less cooling effect on the rear windshield and rear cabin.

The work by Jasni and Nasir in 2012 is interesting. Similar to that observed by Al-

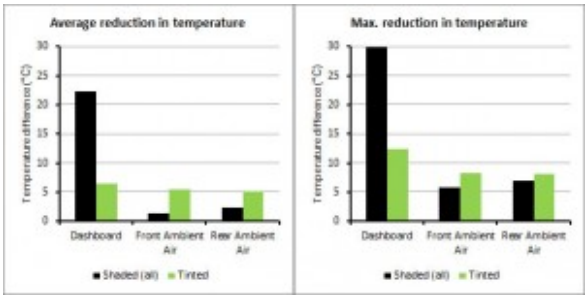
Kayiem and associates, they observed that the car dashboard temperature could reach a maximum of more than 80 degrees Celsius, and by using a sunshade (placed on all car windows, not just on the front window) could cool the dashboard by an average of 22 degrees Celsius (with a maximum reduction of 30 degrees Celsius).



Jasni and Nasir (2012) showed that sunshade (placed on all car windows) cooled the dashboard the most, but it had little cooling effect on the car ambient air (redrawn from Jasni and Nasir, 2012).



Average maximum temperature in the car cabin. Baseline is that without any car cooling methods (redrawn from Jasni and Nasir, 2012).



Average and maximum reduction in temperature by sunshade and tint compared to without any cooling methods (baseline) (redrawn from Jasni and Nasir, 2012).

Interestingly, window tinting did not cool the dashboard by as much as that cooled by the sunshade. Car tint cooled the dashboard by an average of only 7 degrees Celsius (with a maximum reduction of 12 degrees Celsius).

However, window tinting was more effective than sunshade in cooling the car cabin temperature (front and rear ambient air). There was little difference between the car cabin temperature with and without the sunshade protection. The sunshade only cooled the car cabin by an average of 2 degrees Celsius (with a maximum reduction of 6 degrees Celsius), whereas the tint cooled by an average of 5 degrees Celsius (with a maximum reduction of 8 degrees Celsius).

One could of course argue that using a tint with a higher heat rejection rate would cool more the car. The tint used by Jasni and Nasir is on the lower end of quality. The infrared rejection of the tint used by them was 85% for the front windshield and 65% for the rear windshield and all side windows (no TSER or Total Solar Energy Rejection values were given).

Unprotected against the sun, the car cabin temperature could be as high as nearly 60 degrees Celsius. So, even if a good quality tint could reduce the cabin temperature by as much as 10 to 15 degrees Celsius (nearly double that reported by Jasni and Nasir), the car cabin would still feel uncomfortably warm at about 45 to 50 degrees Celsius. Perhaps this is why some people feel that their car tint “does not appear to work”.

But which car window allows in the most heat? As mentioned earlier, I thought the front windshield, being the largest window piece, would allow in the most

heat. Measurements by Al-Kayiem and associates confirmed my hypothesis. Measurements revealed that solar irradiance (that is, the amount of incoming energy from the sun) was the highest for the front windshield, followed by the rear windshield. Computer simulations further revealed that the hot spots within a car cabin are at the front and rear windshields, as well as the ambient air immediately beneath the car roof.

At the end, results from these two studies show that car-cooling methods like a simple sunshade and window tinting do work. Window tint is overall more effective than the sunshade in cooling the car cabin and that window tint cools the car cabin more uniformly than the sunshade. However, the sunshade is unexpectedly far more effective than tint in cooling the car dashboard.

So, here is the bottom line: if you are looking to cool your car cabin, choose a tint with a high heat rejection rate and place a reflective sunshade on the front windshield during parking. If you are on a tight budget, install a tint with a higher heat rejection rate on your front windshield, and if possible, on the rear windshield as well. The side windows can have lower heat rejection rates. *Oh yes*, and pick a light coloured car too. Caveat: bear in mind that such a setup is not perfect; it would not completely insulate your car from heat. You should still expect your car cabin to feel a little warm, perhaps even uncomfortably so, especially after long hours of parking under the burning sun.

References

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