

### The challenge NOW is CO<sub>2</sub>



**by Steve Perham of the Airmax Group**

It seems like Climate Change is in the newspapers and on television daily and the Kyoto agreement appears to be a political hot potato. However the motor industry has come a long way in its struggle to reduce air pollution. New vehicles are the cleanest ever, and improving all the time. Advances in emission control technology have cut hydrocarbons (HC) and carbon monoxide (CO) oxides of nitrogen (NO<sub>x</sub>) emissions to almost nothing. European smog is almost a thing of the past. New fuels offer many benefits. BP's 'Ultimate' for example, has been specially formulated to reduce emissions of unburned hydrocarbons, carbon monoxide, nitrogen oxides, and carbon dioxide.

The greatly enhanced cleaning power of the fuel removes carbonaceous deposits from the engine enabling it to work more efficiently. This improves combustion, and in turn helps to reduce exhaust emissions.

One thing emission control technology has not been able to control is the basic chemistry of combustion itself. The issue now is CO<sub>2</sub> (carbon dioxide).

Almost all motor vehicles today burn some kind of "hydrocarbon" (containing hydrogen and carbon) fuel.

### THE CARBON CYCLE

When anything that contains hydrocarbons is burned, the bonds that bind the hydrogen and carbon atoms together are broken. Heat energy is released and used to power a motor. Burning also causes the hydrogen and carbon atoms to combine with oxygen in the air forming water vapour (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>). That's the basic chemistry of all combustion.

Water vapour is no problem because two-thirds of the Earth's surface is covered with it. So what's a little more? The problem is carbon dioxide. CO<sub>2</sub> is a colourless, odourless and non-toxic gas. Human beings and animals exhale carbon dioxide with every breath they take. This, plus all the CO<sub>2</sub> being produced by every motor vehicle that's being driven, adds up to almost immeasurable of tons of CO<sub>2</sub>.

We would have suffocated in our own CO<sub>2</sub> a long time ago were it not for plants. Fortunately, plants, with the help of sunlight, have the ability to absorb CO<sub>2</sub> from the atmosphere and convert it back into organic carbon compounds (hydrocarbons) that become part of the plant - "photosynthesis." At the same time, plants release oxygen back into the atmosphere, which we breathe and burn up more hydrocarbons.

Historically, the amount of naturally occurring CO<sub>2</sub> in the atmosphere has been 290 parts per million (only 0.0003%). Air is mostly nitrogen (78%) and oxygen (21%). CO<sub>2</sub> is not a pollutant in the traditional sense, but it does retain heat in the Earth's atmosphere. That's why scientists refer to CO<sub>2</sub> as a "greenhouse gas." It traps and holds heat just like the glass in a greenhouse.



## THE CO<sub>2</sub> CHALLENGE

Based on analysis of air bubbles trapped in ice cores taken at the north and south poles, scientists say the level of CO<sub>2</sub> has been gradually increasing since the dawn of the Industrial Revolution in the 1700s. When people started burning wood and coal to fuel industrial steam engines and heat their homes, CO<sub>2</sub> levels started to rise and have been going up ever since. And since World War II, the rate of increase has been accelerating at an ever-quickening pace. The latest count puts CO<sub>2</sub> at over 360 parts per million (about a 25% increase).

As CO<sub>2</sub> levels continue to rise, scientists fear it will cause a gradual warming of the Earth's average temperature, which they report has already gone up almost a couple of degrees, based on historical data. This, they say, has the potential to upset ocean currents, global weather patterns and rainfall possibly having far reaching and negative consequences for agriculture, fishing and life in general. Some fear it may even lead to a melting of the polar ice caps causing the oceans to rise and flood coastal areas.

### **KYOTO PROTOCOL**

Concerns over such dire predictions led to a world summit meeting in Kyoto, Japan in December, 1997. The outcome of this meeting was a proclamation calling for significant reductions in CO<sub>2</sub> emissions by industrialized and developing nations. Though many others nations have signed it (including most of the Europeans), the U.S. has balked at signing because it would call for drastic changes in the American lifestyle and disadvantage the 'Big 3' US car manufacturers.

### **EMISSIONS VERSUS TREES**

If cars and trucks put carbon into the atmosphere and trees remove it, how many trees does it take to offset the carbon released by one sport utility vehicle?

The following calculations may be subject to debate, but here are my ballpark guesstimates:

- One gallon of fuel weighs about 8 lbs. Of that, about 7 lbs. is carbon (the rest is hydrogen).
- If a 4x4 that gets 15 mpg is driven 15,000 miles a year, it will burn 1,000 gallons of fuel. That puts about 7,000 lbs. of carbon into the atmosphere (combined with oxygen as CO<sub>2</sub>).
- A mature tree 40 to 50 feet high weighs around 10,000 lbs. Of that, at least 7,000 lbs. is organic carbon compounds (the exact amount will vary depending on the species and the density of the wood). To reach this size, most trees need 30 to 40 years of growing time. This too will vary depending on the species of tree, its geographical location, soil conditions and weather. Trees in hot, wet tropical climates grow a lot faster than trees in northern climates.

Assuming these estimates are reasonably accurate, one mature tree contains about as much carbon as the 1,000 gallons of fuel burned by a typical 4x4 in a year.

But remember it takes 30 to 40 years for the tree to absorb all that carbon from the atmosphere. The process of "photosynthesis" takes time. Leaves use sunlight and water to convert CO<sub>2</sub> from the atmosphere into the sugar the tree uses to grow and build more wood fibre. The tree's average carbon uptake, therefore, may only be about 200 lbs. of carbon a year.

So we calculate it takes at least 35 medium-sized healthy trees to convert CO<sub>2</sub> into wood to offset the carbon released by driving a 4x4 15,000 miles a year.

What happens to the carbon once it's been taken out of the atmosphere by the trees and bound up in the wood?

It stays there until something happens to the tree. If a tree dies of old age or is blown down in a storm some of the carbon is slowly released back into the atmosphere as CO<sub>2</sub> while the wood rots, but this may take several years. Much of the carbon remains in the soil as organic nutrient for other plants, worms and insects.

If the tree is cut down and made into lumber, the carbon also stays bound up in the lumber until something happens to whatever the lumber was used to build.



## THE CO<sub>2</sub> CHALLENGE

But if the tree is destroyed in a forest fire, burned to clear land or cut for firewood, all of the carbon that's been stored in the tree since it was a sapling is immediately released back into the atmosphere as CO<sub>2</sub>. Consequently, burning a tree is the carbon equivalent of driving a fuel-guzzling 4x4 15,000 miles a year.

In Brazil alone, nearly 3 million acres of rain forest are being slashed and burned into oblivion every year. Multiply these acres times the amount of carbon being put back into the atmosphere and it far outweighs the CO<sub>2</sub> that's being released by the entire U.S. vehicle fleet!

The point here is that no matter what we do to minimize pollution or improve fuel economy it will make little difference in restoring the atmospheric carbon balance if deforestation continues to run rampant in other parts of the world. The losses there will more than negate any gains we might be able to achieve here.

What's really sad about all of this is that forest land cleared by slash and burn agriculture is only productive for a few years because the soil is thin and poor. It soon becomes rock hard forcing the farmers to clear even more land. To make matters worse, the cleared land doesn't come back. The trees are gone forever along with their ability to absorb carbon from the atmosphere. And without the trees, there's not much hope of restoring a natural atmospheric carbon balance.

### **FUTURE CONSEQUENCES?**

With more vehicles producing carbon and fewer trees left to absorb it, don't expect the atmosphere's carbon balance to improve any time soon. The scales have probably tipped irreversibly toward higher and higher levels of CO<sub>2</sub> for the foreseeable future.

The biggest unknown is what effect this will eventually have on all of us. Nobody argues with the fact that the amount of CO<sub>2</sub> in the atmosphere is steadily rising because of human activity. What we don't know is what the long-term consequences of a CO<sub>2</sub> imbalance will be or how it will actually affect our daily lives. Waiting to find out may prove costly if we miss the window of opportunity to make significant changes now.

Many environmentalists say one step we can take now to reduce CO<sub>2</sub> emissions is to improve the fuel economy of all classes of vehicles.

### **TECHNOLOGY TO THE RESCUE**

Electric vehicles are still on the fringe and will probably stay there because of lagging battery technology. Electric vehicles that emit no pollutants and no CO<sub>2</sub> certainly make sense in polluted urban environments. They're the ultimate energy-efficient vehicles for stop-and-go driving because they waste no energy when they're stopped in traffic. But nobody has yet come up with a cheap, lightweight, safe, quickly rechargeable battery. And even if they did, it would take years for the new technology to go into mass production and for the public to accept it.

There's also the issue of whether or not electric vehicles would actually reduce pollution. The electricity needed to recharge the battery has to come from another power source. Unless that power source is nuclear, hydroelectric, wind, solar or geothermal, there is little or no net reduction in pollution or CO<sub>2</sub> because burning coal or natural gas generates most electrical power in this country. No new nuclear power plants have been built in the U.S. for over 25 years, and many 'nukes' are now reaching retirement age and will have to be decommissioned. Unless there is a rebirth of nuclear energy or a large-scale shift to alternative sources of clean power (which are more expensive and require huge financial investments), electric vehicles aren't going far.

Even with an advanced battery breakthrough, it's questionable whether the existing power infrastructure has the capacity to supply the needs of an expanding fleet of electrical vehicles. California has been experiencing a mini-energy crisis of its own recently. Imagine how bad their situation would be today if even 5 to 10% of their vehicles were electric.



## THE CO<sub>2</sub> CHALLENGE

### FUEL CELLS & HYDROGEN

Fuel cells currently hold the greatest promise for solving our environmental concerns over pollution and CO<sub>2</sub>. A fuel cell produces electricity by combining hydrogen and oxygen. The only by-product is water vapour - provided the fuel source is pure hydrogen.

Hydrogen is one of the most abundant elements on Earth. It can be made from natural gas, oil, even coal, or by using electricity to break down water into hydrogen and oxygen. Even so, it's not cheap to produce and contains less energy than hydrocarbon fuels.

Hydrogen is also a hard-to-store fuel. Because it's a gas, it has to be compressed at extremely high pressure (3,000 to 4,800 psi). This requires large, heavy, expensive fuel tanks that reduce a vehicle's driving range and fuel economy. It can be liquefied to increase its storage density, but this requires special insulated cryogenic storage tanks to keep the fuel at -253°C. Another storage method is to use "metal hydrides" or activated carbon that absorb hydrogen like a sponge. But these approaches are bulky, heavy and expensive. What's more there is no distribution system for hydrogen like there is for petrol, diesel fuel or even natural gas. So even if you had a hydrogen-powered vehicle, you'd have a hard time finding a place to fill it up.

Time will tell which technologies will eventually help us meet our environmental challenges. It's not just motor vehicles that bear the brunt of reducing pollution and CO<sub>2</sub> emissions. It's all forms of energy consumption and power generation worldwide as well as the issue of deforestation. Hopefully, we can come up with solutions that satisfy everybody's concerns and needs while there is still time.

Airmax Developments Limited is monitoring fuel usage from vehicle variants and displaying the data per journey on a web page. It is researching the effects of driver style on fuel burn to see how the actual CO<sub>2</sub> compares to the Governments published figures as influenced by driver styles.

