

**Step 1:** Biodiesel is an alternative fuel made from plants. Its increased usage is expected to reduce dependence on foreign oil. There is concern, however, that the use of biodiesel may increase pollution. A study was conducted by the National Renewable Energy Laboratory to look at emissions of oxides of nitrogen ( $\text{NO}_x$ ), total hydrocarbons (THC), carbon monoxide (CO), and particulate matter (PM) from three different transit buses (identified as Transit Bus #1, #2, and #3), a motor coach, and a school bus. The tests were conducted using simulated driving conditions.  $\text{NO}_x$  and THC react together in sunlight to form ground-level ozone.  $\text{NO}_x$ , PM, and ozone cause acute and chronic lung problems. CO causes cardiovascular and central nervous system effects.

The attached tables show selected results of this study using petroleum diesel fuel (Table 1) and B20, a mixture of 80% petroleum diesel fuel and 20% biodiesel (Table 2). Calculate the totals and averages for each column for both tables, and fill in the appropriate rows. Also, calculate the percent changes from Table 1 to Table 2 for the averages of each column, and fill in the appropriate row in Table 2.

**Table 1: Pollutant Emissions from Diesel Vehicles Using Petroleum Diesel Fuel**

Type of Diesel Vehicle	$\text{NO}_x$ (grams/mile)	THC (grams/mile)	CO (grams/mile)	PM (grams/mile)	Fuel Economy (miles per gallon)
Transit Bus #1	19.80	0.871	3.60	0.2740	4.67
Transit Bus #2	19.44	0.794	3.43	0.3210	4.54
Transit Bus #3	19.78	0.824	3.04	0.3079	4.60
Motor Coach	7.75	0.230	4.05	0.2538	6.63
Conventional School Bus	9.78	0.373	8.95	0.6954	5.01
Total					
Average					

**Table 2: Pollutant Emissions from Diesel Vehicles Using 80% Petroleum Diesel Fuel and 20% Biodiesel**

Type of Diesel Vehicle	$\text{NO}_x$ (grams/mile)	THC (grams/mile)	CO (grams/mile)	PM (grams/mile)	Fuel Economy (miles per gallon)
Transit Bus #1	18.65	0.625	2.63	0.2264	4.56
Transit Bus #2	18.67	0.571	2.73	0.2150	4.45
Transit Bus #3	19.04	0.592	2.48	0.2447	4.51
Motor Coach	7.96	0.190	3.15	0.1825	6.54
Conventional School Bus	10.39	0.300	6.93	0.5284	4.99
Total					
Average					
% Change Between Table 1 & 2 for Averages					

**Step 2:** How does the presence of 20% biodiesel in the fuel affect the emission of pollutants and the fuel efficiency of the vehicles?

**Step 3:** a. Are the results consistently reduced for all four pollutants for all five vehicles?

b. How does the consistency of results relate to your confidence in the results?

c. How might inconsistencies impact your interpretation of the results, especially with small changes in percentage (e.g., 1% or 2% changes)?