74-32 DWP

# Evaluation of Two Prototype Suzuki Fronte Vehicles

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## Background

Suzuki Motor Company Limited contacted EPA requesting confirmatory testing of a low emission prototype vehicle powered by a two stroke engine. Because the vehicle had demonstrated potential for achieving the 1976 statutory emission levels in tests run by Suzuki, EPA agreed to conduct a series of tests on these vehicles.

## Vehicle and Emission Control System Description

Two vehicles of a subcompact size going under the name "Fronte" were tested. Both vehicles were identical and had been driven approximately 6550 kilometers (4000 miles). They were powered by three cylinder, water cooled two stroke engines of 356cc displacement (21.7 CID). The vehicles were of the rear engine rear drive type. Both were equipped with four speed manual transmissions. Curb weight of both vehicles was 546 kilograms (1200 pounds).

The emission control systems incorporated several novel features. A fuel distillation system was used for cold starting. A small quantity of the more volatile components of the normal gasoline supply is distilled off using an electric heater and stored for use during cold starts. This feature lowers the requirement for enrichment during cold start and thus reduces the cold start hydrocarbon and carbon monoxide emissions.

These vehicles also used a thermal reactor in combination with an air pump and timed exhaust system spark ignition for combustion of the hydrocarbon rich exhaust found typically in two stroke applications. Suzuki calls their thermal reactor system "Exhaust Port Ignition Cleaner" (EPIC).

To insure good displacement utilization two stroke engines normally experience some over flow of fresh intake air/fuel charge into the exhaust before compression is initiated. This phenomena results in pulses of hydrocarbon and air in the exhaust of a readily combustible mixture. EPIC, by providing for a properly timed spark ignition source in the exhaust system, combusts these fuel/air pulses.

An air pump is employed with this system. Air is injected into the exhaust ports and thermal reactors only when the throttle is less than 25% open and the engine speed is greater than 2400 rpm. Due to the carburetion in this mode the exhaust becomes overly rich thus more oxygen is required for after combustion in the exhaust system.

The vehicles control systems also used spark retard during cold-start for rapid engine and thermal reactor warm-up.

Test Program

Several 75 FTP as described in the November 15, 1972, Federal Register were conducted on each vehicle. In addition one high speed non-metropolitan cycle was run on one of the vehicles.

Test Results

Test results are given in the attached table. It can be seen that 1976 statutory emission levels can be met with these vehicles. Fuel consumption measured during this testing is below what would be expected for a car of this weight class. 1975 FTP fuel consumption for a vehicle of this weight class powered by a conventional four stroke engine would be estimated at a minimum of 9.4 liters per 100 kilometers (25 mpg). The use of a two stroke engine is probably the cause of this poor economy.

The curb weight of these vehicles was 546 kilograms (1200 pounds) each. Test inertia would thus calculate to be 680 kilograms (1500 pounds). EPA's Ann Arbor laboratory has a minimum capability of 794 kilograms (1750 pounds) on its dynamometer. Thus all EPA testing was conducted at 794 kilograms (1750 pounds). Suzuki tested these vehicles at 680 kilograms (1500 pounds). Their typical 75 FTP results at 680 kilograms (1500 pounds) are as follows: 0.12 g/km (0.20 g/mi) HC, 1.20 g/km (1.93 g/mi) CO, 0.14 g/km (0.23 g/mi) $NO_x$ and 10.9 liters per 100 kilometers (21.5 MPG).

Conclusion

1) 1976 statutory emission levels were achieved consistently with two low mileage subcompact Suzuki vehicles powered by two stroke engines.

2) Fuel economy was at least 30% less than what would be expected for a vehicle of this weight class.

## Test Results

### '75 FTP Results

| Vehicle No. | HC | | CO | | NOx | | Fuel Consumption | |
|---|---|---|---|---|---|---|---|---|
| | g/km | g/mi | g/km | g/mi | g/km | g/mi | l/100km | MPG |
| 6 | 0.096 | 0.155 | 0.764 | 1.23 | 0.15 | 0.24 | 13.2 | 17.8 |
| 6 | 0.131 | 0.211 | 0.839 | 1.35 | 0.14 | 0.22 | 13.2 | 17.8 |
| 7 | 0.195 | 0.314 | 2.96 | 4.77 | 0.12 | 0.19 | 13.4 | 17.6 |
| 7 | 0.065 | 0.104 | 1.22 | 1.97 | 0.12 | 0.20 | 12.9 | 18.3 |
| 7 | 0.079 | 0.127 | 7.36 | 3.80 | 0.11 | 0.18 | 13.0 | 18.1 |
| Avg. | 0.113 | 0.182 | 1.63 | 2.62 | 0.13 | 0.21 | 13.1 | 17.9 |
| '76 Statutory Standard | 0.255 | 0.41 | 2.11 | 3.4 | 0.25 | 0.4 | -- | -- |

### Highway Cycle Results

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 0.006 | 0.01 | 0.075 | 0.12 | 0.11 | 0.17 | 8.40 | 28.0 |