| System | Passengers | Energy Consumption | Energy Cost | CO Emitted |
|---|---|---|---|---|
| Electric bus | 12 | 1.0 | 1.0 | 1.0 |
| Electric bus and transporter | 12 | 1.12 | 1.2 | 1.0 |
| Diesel bus | 12 | 1.12 | 2.5 | 662.0 |
| Diesel bus and transporter | 12 | 1.25 | 2.1 | 342.0 |
| Private automobile | 1.3 | 6.25 | 27.4 | 143.0 |
| Private automobile and transporter | 4 | 2.25 | 4.5 | 80.0 |
| Gasoline bus | 12 | 1.18 | 3.6 | 682.0 |

The all-electric bus system was established as the base line, for all other systems or system combinations used more energy at higher cost and emitted more pollution.

## PROPULSION SYSTEMS STUDIES OF DUAL-MODE VEHICLES

Tibor Bornemisza, Rohr Industries, Inc.

Performance and fuel economy of the dual-mode vehicle was investigated by using three alternative propulsion methods: turbine electric, diesel electric, and diesel mechanical. The turbine and diesel electric vehicles are driven by a three-phase induction motor through a conventional rear axle. Motor speed and torque are controlled by a solid-state variable frequency, variable voltage power supply. On the guideway, 600 Vdc electric power is picked up by a conventional wayside power collector. Off guideway, the electric power is supplied by a lightweight high-speed alternator driven by either a recuperated gas turbine or a diesel engine. The output of the alternator is converted to direct current by a three-phase full-wave silicon bridge rectifier.

The diesel-mechanical propulsion engine provides the power for both on- and off-guideway operations. A hydromechanical transmission with infinitely variable speed is used. The output torque characteristics of this transmission are similar to those of the electric drive system.

A computer model was used to predict vehicle performance. The parameters analyzed include fuel consumption, acceleration, cruise, and grade performance. All three propulsion systems offer a satisfactory solution for both on-guideway and off-guideway propulsion requirements of the dual-mode vehicle. The high performance, smooth power flow, low noise, and emission-free characteristics make the electric propulsion attractive for future guided-vehicle applications. However, some of the components in the electric propulsion system have yet to be proved under the rigorous requirements of transit service. The high investment cost associated with the installation of the wayside power supply could hardly be justified by the derived benefits such as fuel economy and low pollution for an experimental application of the dual-mode system principle at the present time.

The diesel-mechanical propulsion, representing the low technology approach, provides a satisfactory solution for the propulsion requirements of the dual-mode system. Reliability and low pollution characteristics make the diesel engine the most accepted powerplant for transit coach operations. The hydromechanical transmission represents a significant advancement in transmission technology for heavy-duty vehicles. It provides infinitely variable speed control for the vehicle and enables engine operation at optimum fuel economy. The lower system cost and familiarity with diesel engines could eliminate possible points of resistance to unconventional propulsion systems on the part of transit companies when the dual-mode transportation system is considered as one of the possible alternatives for improving their services.

## HYBRID-DUAL-MODE BUS PROPULSION SYSTEM OF INTERNAL COMBUSTION ENGINE AND ELECTRIC MOTORS

Joseph P. Finelli and Fred E. Langhorst, Transportation Systems Division, General Motors Corporation

This paper discusses the vehicle propulsion system to be used in the General Motors dual-mode transit system. The rationale for selection of the system configuration and a general description of the hardware and automatic control logic are included. The GM dual-mode vehicle propulsion system consists of two independent power plants and drive lines. The primary power train consists of an internal combustion engine and front-wheel drive package, and the secondary power train includes electric motors driving the rearmost vehicle wheels. Energy for the secondary drive motors will be supplied by on-board batteries. The two power trains are capable of operating independently or as a parallel hybrid. A summary of vehicle performance is included along with a discussion of the value associated with using the secondary power train as a backup or as a hybrid with the primary.