origin of unburned hydrocarbon emissions in piston engines. The process of flame quenching by the cold walls had been determined to be of negligible importance as a source of unburned hydrocarbon emissions from DHC engines. Rather, piston ring and head gasket crevice volumes and the absorption/desorption by lubricating oil filters and combustion chamber deposits are largely the controlling factors. This new understanding of the physical processes involved has allowed engine designers to focus their efforts on the difficult engineering tasks of reducing these crevice volumes and of solving the continuing problems in warm-up and transient operation. These efforts should lead to the resolution of a major technical limitation in use of the DHC engine concept.

Understanding "Engine Knock"

A significant increase in the thermodynamic efficiency and a corresponding decrease in the fuel consumption of automotive spark-ignition engines can be achieved with an increase in the compression ratio. However, increases in the engine compression ratio are limited by the onset of engine knock and the possible risk of engine damage. Knock is the engine response to a rapid, non-uniform pressure rise in the combustion chamber. Such high rates of pressure rise appear to be caused by the nearly uniform autoignition of the end gases before the flame passes through them. The results of recently completed experiments and kinetic modeling simulations of the compression ignition process have provided new insight on the problems of autoignition and engine knock. It is now known that the role of low temperature chemistry in the end gases is to provide enough heat release to increase end-gas temperature sufficiently to cause hot ignition. The exact kinetic mechanism is under continued investigation. ECUT research provides clarification of which factors are most important, so that future work can be better directed toward possible mitigation of problems. It may even be found that these thermal, fluid mechanical, and chemical mechanisms can be harnessed and controlled to provide rapid energy release, high compression ratio, and minimum risk of mechanical damage. These should lead toward higher efficiency, cheaper operation, and a better competitive position for U.S. products.

Combustion Characteristics of Alternative Diesel Fuels

Cetane numbers have been successfully used since the 1930s to rate the ignition quality of diesel fuels on the market. However, attempts to rate the ignition quality of a wider variety of alternative fuels being considered for use in diesel engines have met with limited success. The lack of an accurate rating procedure poses a serious problem for engine manufacturers and fuel producers as they try to assess engine designs and alternative fuels for use when the current supply of high-quality diesel fuel is depleted or disrupted. Recently, tests of several potential alternative fuels in diesel engines have found that ignition quality did not always correlate with cetane number. The fuels tested included possible near-term fuels and fuels being considered for emergency use. Under DOE support, the ignition characteristics of several alternative fuels for diesel engines were measured in a constant volume combustion "bomb" to investigate the shortcomings of the current American Society for Testing and Materials (ASTM) cetane rating method when applied to these fuels. In a parallel effort, the same fuels were tested in operating direct- and indirect-injection diesel engines. It was found that combustion bomb testing provides additional essential and complementary information to conventional engine testing. Important differences in the low-temperature ignition kinetics of alternative fuels were detected with the bomb technique which were not evident in the existing cetane rating procedure. The bomb tests indicated that modification of the current procedure would be required to improve the rating of future broad-specification fuels. This fundamental method of characterizing combustion of fuel sprays in diesel engines should lead to better