

Informal Document No. ⑥
(Informal meeting of the GRPE working
group on particulate matter emissions;
and
42nd GRPE, 28 - 31 May, 2001,
agenda item 2.)

**LASER-INDUCED INCANDESCENCE INSTRUMENT
AS TOOL FOR MEASURING EXHAUST PARTICULATES**

Transmitted by the expert from Canada

Canada shares GRPE's concern regarding ultra-fine Particulate Matter (PM) emissions. At present time, Canada is conducting research to develop instrumentation to properly measure concentration and size of the carbonaceous content of the PM. The goal of this informal document is to make the GRPE aware of the Canadian research and to offer a presentation of results and/or a demonstration of the developed test equipment during the next GRPE session.

Vehicles equipped with new technologies, such as; direct-injected gasoline engines, homogeneous charge compression ignition engines, hybrid power train systems, etc., will play an important role in the strategy to improve fuel economy. Canada is concerned with the fact that these technologies produce a large number of ultra-fine particles (smaller than 2.5 micrometers), and that these particles are not adequately addressed by current emission regulations. If the ongoing research on the effect of these ultra-fine particulates on human health produces strongly negative results, there is a potential for new emission requirements, with unknown impact on the efficiency-improvement potential of these new engine technologies.

The World Health Organisation (WHO) presented a paper to the UNECE WP.29 - GRPE-41 on health risks related to the emission of particulate matter (PM) and resulting air pollution. The presentation concentrated on PM of 10 and 2.5 micrometers. It stated that there is no known threshold, or safe level related to the effect of PM on health. Although the study was not yet concluded, it pointed to the fact that with PM 2.5 the risk to health was higher in the form of short and long term effects on pulmonary/respiratory as well as cardio-vascular systems. Ultra-fine particles like those produced with direct-injected gasoline engines seem to be even more dangerous to humans. Given that 40 per cent of the ultra fine particles in the air were contributed by road transport, this is an area of concern.

Other than the obvious health concerns, the problem with the introduction of these new engine technologies is that the standard gravimetric technique to calculate PM concentration is not able to accurately measure these ultra-fine particles.

The Combustion Group of the National Research Council of Canada (NRC) is developing a Laser-Induced Incandescence (LII) instrument as a practical tool for measuring exhaust particulates. LII is a technique for measuring spatially and temporally resolved particulate concentration and size. LII has orders of magnitude with more sensitivity than the standard gravimetric technique, and thus offers the promise of real-time measurements and adds the increasingly desirable size and morphology information.

Currently, the NRC and its commercialisation partner Artium, are working on projects to measure particulate concentration and size from diesel engines, direct injection spark ignition engines, gas turbines, carbon black furnaces, and research flames. Other applications include evaluating fuel composition and additive effects on PM, and measuring/monitoring stack emissions from industrial furnaces, power generation plants, and incinerators.

Primary particle sizes have been measured over the range of PM 0.010 to PM 0.100 (10 to 100 nm), with an error of $< \pm 10\%$. Research on aggregate sizing with a combined LII/inelastic scattering technique will provide size distributions over the range PM 0.001 to PM 1. Concentrations have been measured in the range from 5 ppt to 20 ppm.

A functioning and portable version of the LII Instrument will be constructed in the coming months. Canada is prepared to offer a presentation of results and/or a demonstration at the next GRPE in Geneva if this committee so wishes.
