

# New Generation of Internal Combustion Engine


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## Opinion

It is a green industry that closely combines efficient and clean combustion technology, artificial intelligence technology and electrification technology. It was thought that there were limits to the harmful emissions of NO<sub>x</sub> and soot. But a new generation of internal combustion engines pushes that limit. A famous academic conference USCAR was held in 2010, where participants fully reviewed and evaluated the results of many years of basic research and technological progress around the world, made a scientific evaluation of the future development potential of the internal combustion engine thermal efficiency, and proposed that the «short term» thermal efficiency could reach 60%. In the «long term» it could be closer to 85 percent. High thermal efficiency results in low fuel consumption and low CO<sub>2</sub> emissions. That prediction is coming true in China. However, even though the IC engine has been greatly optimized, with the general increase of human society's concern about air quality and greenhouse gas emissions, new power technologies such as electric vehicles and fuel cell vehicles have been highly valued by governments and automobile companies around the world. Some politicians and journalists in Europe have called for the elimination of internal combustion engines from intracity transportation, as well as the use of wind and solar power as primary energy sources. However, there is still a wide gap between reality and hope. Despite significant advances in wind and solar technology, the application of renewable energy still faces technical problems such as «grid connection and storage».

The IC engine industry cannot happen like the electronic information industry, there is a short-term leapfrog development. The popularization of renewable energy will be a long process, while looking for new energy sources and alternative power machinery, the IC engine will continue to receive widespread attention. Especially for engines such as commercial vehicles, construction machinery, agricultural machinery, inland and maritime transport and military power machinery, there is no alternative power unit in terms of torque, power, energy consumption and durability. According to the statistics of the transport department, in the past five years, road transport accounted for more than 70% of the country's total freight volume and 80% of the total passenger transport. The IC engine consumes about two-third of the total oil in China every year. It goes without saying that in the future for a long time, the IC engine is still an important basic industry in China and the IC engine is still dominant in automobiles and all kinds of power plants. Attention and continuous development of efficient and clean IC engine technology is the long-term needs of national economic and social development.

## Demand and prospect of power machinery combustion technology

The fundamental problem of power machinery engine combustion technology is to reduce the consumption of fossil fuels, improve the energy efficiency of the engine, reduce carbon dioxide emissions and save fossil energy. Second, further reduce harmful emissions,

especially reduce harmful emissions from actual roads and engines in actual operation, further reduce pollution to the atmospheric environment and protect human health.

### **New combustion technologies**

The combustion of IC engine is mostly the combustion of spray, and the characteristics of spray have the most direct influence on the combustion path of spray revealing the influence of the equivalent ratio distribution of spray on the combustion speed and release temperature during the spray combustion process, and then predicts the composition of combustion products. The significance of this finding is that it suggests that lean HCCI, in which fuel is sprayed «close to» lean and thin, may be the most efficient and cleanest mode of combustion. It can eliminate any conditions that produce carbon smoke and nitrogen oxides. And it is reduced to the mass fraction of the dilute mixture ( $1 \geq \varphi \geq 0$ ) in the spray should be greater than 40-50%. Our research proves that the high efficiency of high-octane compression combustion process should not rely on flame propagation, but on formation of volumetric propagation by the mixture reactivity control, and the combustion speed is significantly increased.

### **Engine transient combustion process control (RDE Technology)**

Since the launch of emission regulations in the early 1990s, the test cycle and detection instruments of emission regulations in countries around the world are constantly improving. It was not until the mid-2010s, with the advancement of IC engine technology, that research began to be carried out on emissions regulations for actual roads. The Actual Road and Actual Operation Emission Regulation (RDE) is essentially a transient combustion process,

including emission control of the transient combustion process at low temperatures and high altitudes. The core technology of RDE is that IC engine must have a comfortable transient control capability and ensure that IC engine emissions are not excessive under possible road conditions and have strong power and fuel saving characteristics. This is a new issue of IC engine emission control and a new requirement for atmospheric environmental protection in the new era.

### **Low exoergic loss thermal cycle and combustion process research**

Exergy is a measure of a fuel's work ability. In the process of energy conversion, a fuel goes through combustion, heat transfer, flow and other processes, which all reflect a process of entropy increase. Exoergic loss can be reduced to improve thermal efficiency. Our research has proved that temperature, pressure, equivalent ratio and oxygen concentration are all important parameters affecting exoergic loss. The higher exoergic concentration is, the shorter the combustion duration and the higher the thermal efficiency, but there is an optimal value, which adds a lot of changes and suspense to combustion control, which is exactly what combustion science and technology need to pursue and explore. From the point of view of thermal cycle, there are also many problems to be explored, including variable thermal cycle. In short, it will be a long process for renewable energy or controllable new energy to replace fossil energy, and it is a process of continuous initiation and evolutionary progress of all kinds of science and technology. Until then, combustion has always been the basic way to produce power. Combustion science and technology will play a key role on the road to carbon peak and carbon neutrality, and combustion science and technology workers have a long way to go.