DUST PLASMA ENGINE

A.T. Elgendy\textsuperscript{1}

\textit{Faculty of Science, Physics Department, Ain Shams University,}
\textit{Abbassia, Cairo, Egypt}
\textit{and}
\textit{The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy.}

Abstract

Recently, and towards the end of the previous century, several efforts have been made to study heat engines which are very important for factory machinery, cars, airplanes and trains. In this presentation I will introduce a new idea for a mechanism through which we may increase the efficiency of a piston as much as possible to its virtual maximum value, as well as to produce a cleaner environment.

MIRAMARE – TRIESTE
December 2006

\textsuperscript{1} bin_elgendy@yahoo.com
Introduction

A heat engine is a device that transforms heat partly into work or mechanical energy.

- Matter inside the engine undergoes inflow and outflow of heat, expansion and compression, and sometimes changes of phase.
- The simplest process is the cyclic process through which the heat engine, first
  - absorbs heat from the source at a higher temperature
  - and then rejects some heat at a lower temperature

Energy flow diagram of heat engine

- Heat $Q_H$ is supplied to the engine by the hot reservoir (the amount of heat is shown by the width of pipelines).
- Heat $Q_C$ is rejected from the engine into the cold reservoir in the exhaust.
- The portion of the heat supplied by the engine converts to mechanical work ($W$).

\[ Q = W = Q_H + Q_C = |Q_H| - |Q_C| \]

\[ \text{Thermal efficiency} = e = \frac{W}{Q_H} = 1 - \frac{|Q_C|}{|Q_H|} \]

Internal-combustion engines

There are generally four strokes in a combustion engine.

- **Intake stroke** Intake valve opens, piston descends, volume increases from minimum $V$ to maximum $rV$ ($r$ is compression ratio).
- **Compression stroke** Intake valve closes, piston compresses adiabatically to volume $V$.
- **Power stroke** Spark plug ignites, heat gas expands adiabatically back to volume $rV$.
- **Exhaust stroke** Exhaust valve opens, the combusted gas is pushed out.
The Otto cycle

This is an idealized model of the thermodynamic process in a gasoline engine.

From figure (1) we can describe the following

- from (a’) to (a) the system admits the fuel
- from (a) to (b), the system compresses adiabatically
- from (b) to (c), heat $Q_H$ is added by burning gasoline by isochoric process
  \[ Q_H = \Delta U = n C_V (T_C - T_b) > 0 \]
- from (c) to (d), the system expands adiabatically.
- from (d) to (a), the gas is cooled to the temperature of the outside air, heat $Q_C$ is rejected by isochoric process
  \[ Q_C = \Delta U = n C_V (T_a - T_d) < 0 \]
Adiabatic Process

\[ T_v(rV)^{-1} = T_v V^{-1} \quad \text{and} \quad T_v(rV)^{-1} = T_v V^{-1} \]

\[ \eta = \frac{Q_{in} - Q_{out}}{Q_{in}} = \frac{C_v(T_3 - T_2) - C_v(T_4 - T_1)}{C_v(T_3 - T_2)} \]

\[ \eta = \frac{C_v(T_3 - T_2) - C_v(T_4 - T_1)}{C_v(T_3 - T_2)} \]

\[ \eta = (1 - \frac{1}{r^{r^{-1}}}) \]

where, \( r = \frac{V_1}{V_2} \).

The idea proposed

We will try to generate a dusty plasma within gasoline [1-2] by many methods including adding active materials such as C-60 to the benzene inside the piston…. and exciting this mixture by applying ultra short high intensity pulse lasers, very high voltage, sparks, as well as a strong electric field to the piston as shown in Fig (2).

In this case, the results of equation (1) will be different due to the inclusion of the excited energy of dusty plasma mixed, for example, with gasoline and C.60; and will be written as follows:

\[ \eta = \frac{Q_{in(2)} - Q_{out}}{Q_{in(1)}} = \frac{C_v(T_3 - T_2) + H_1 - C_v(T_4 - T_1)}{C_v(T_3 - T_2)} \]

\[ \eta = \frac{C_v(T_3 - T_2) - C_v(T_4 - T_1)}{C_v(T_3 - T_2)} + \frac{H_1}{C_v(T_3 - T_2)} \]

\[ \eta = (1 + \frac{H_1}{C_v(T_3 - T_2)} - \frac{1}{r^{r^{-1}}}) \]

where, \( H_1 \) is extra energy released due to existing dusty plasma and the increased movement of the piston due to the applied fluctuated electric field.
i. Dust plasma generated by applying any of the methods mentioned, such as ultra short high intensity pulse lasers or sparking to a benzene with C.60.

ii. Fluctuating electric field which is one of the general mechanisms for heating dust particles and a good controlling method for a piston.

**Condition of efficiency (η) equal one (η ≈ 1)**

\[
\left( \frac{H_1}{C_v(T_3 - T_2)} \right) - \frac{1}{r^{\gamma-1}} = 0
\]

\[
\frac{H_1}{C_v(T_3 - T_2)} = \frac{1}{r^{\gamma-1}}
\]

\[
H_1 = \frac{C_v(T_3 - T_2)}{r^{\gamma-1}}
\]
Conclusion

1. We are hence able to increase the efficiency of the machine.
2. We are able to close the efficiency gap that exists between octane 80 (dust-filled fuel) and octane 92 (highly volatile).
3. We are able to rid the environment of air pollution by generating free ions and electrons in the air such as (N, O).
4. We are able to decrease the use of benzene.

References

1. The interactions of ultra short high intensity pulse lasers with large molecules and clusters
   Shuji SAKABE (Graduate School of Engineering and Institute of Laser Engineering, Osaka University)

2. Single-particle Langevin model of particle temperature in dusty plasmas,
   R. A. Quinn and J. Goree (Department of Physics and Astronomy, The University of Iowa, Iowa City)