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Overview of Fire in Internal Combustion Engines

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1. Problem Statement

The reason I conducted this research is because knowledge about fire is still quite new to readers, and there is little accurate research on what fire is.

Previous knowledge includes thermodynamic theory, quantum theory of molecular collisions, physics theory of radical velocity, and the algorithm of convolutional variable transformation.

The main purpose of this research is to understand precisely what fire is by observing fire in internal combustion engines. We will simulate the heat and work graphs as a function of crankshaft rotation to understand the combustion process occurring in internal combustion engines.

2. Problem Solving

Research methods to address the problem include using quantum theory, combining quantum physics theory and molecular collision theory with thermodynamics, and simulating heat and work graphs in Excel.

3. Proposed solutions

Based on the current state of the research problem, the solutions to address the remaining issues are work diagrams and heat diagrams simulating the process of an internal combustion engine.

4. Results achieved

4.1 Initial data

Engine power N_e = 150 (Kw)

Crankshaft rotation speed n = 1500(vg/ph)

Cylinder diameter D=150s

Piston stroke S=180(mm)

Working capacity V_h=3,180862562

Number of cylinders i=6

Compression ratio ε=14,5

Order of work (1- 5 -3-6-2-4)

4.2 Parameters to select

Ambient pressure P_o=P_k=0.1 (Mpa)

Ambient temperature T_o=T_k=297°K

Intake pressure P_a=0.09 Mpa
Exhaust gas pressure P_r=0.107 Mpa
Level of refrigerant heating ΔT=38ºC
Residual gas temperature T_r=1000ºK

4.3 Loading Process

$$P_e = \frac{P_r.V_c}{V_c + V_{hi}} + \frac{P_o.\eta_v.V_{hi}}{V_c + V_{hi}}$$

V_c: volume ratio
V_{hi}: instantaneous volume V_{hi}

$$T_a = \frac{\frac{V_c.m_c v''.T_z}{V_c + V_{hi}} + \frac{V_{hi}.m_c v.(T_k + \Delta T).\eta_v}{V_c + V_h}}{\frac{V_c.m_c z}{V_c + V_{hi}} + \frac{V_{hi}.m_c v.\eta_v}{V_c + V_{hi}}}$$

$m_c v''$ = a_v”+b_v".T=23,10158822

$m_c v$ = a_v+b_v.T=21,57321688

4.4 Compression Process

$$P_c = P_a.\varepsilon^{n1}$$
$$T_c = T_a.\varepsilon^{n-1}$$

4.5 Combustion Process

Most people think fire is just fire. That's true. But if I were to complicate it a little, I think fire is a process of energy breakdown. The world's leading scientists have created theories to describe everything. I think so too, and have tried to describe fire in a combustion engine. So, I think fire is just the name for a series of energy breakdown cycles of a phenomenon. And most of life depends on fire. Medicine, transportation, cooking, etc.

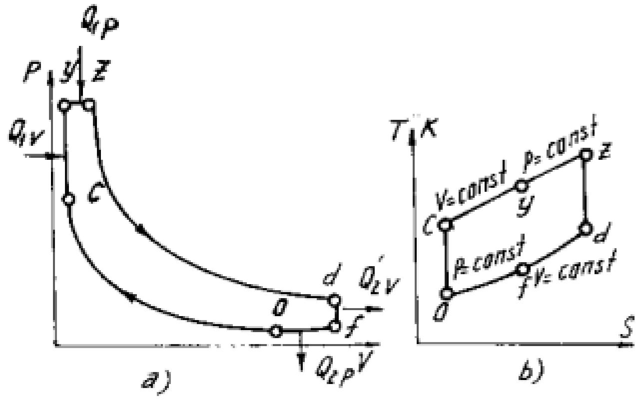
If you can control fire, you truly possess great power.Since I was a high school student, in my final year, I read a story and wanted to go to university. I worked hard to catch up on my knowledge. I passed the exam. Continuing through five years of university, although there were many unexpected things, there was still a glimmer of hope within me. Learning everything on my own was difficult, so sometimes I really wished I had a teacher. Someone gave me a great deal of knowledge so I could walk on my own two feet. But that wasn't the case; almost all my teachers only instilled in me feelings because their failures were too numerous, while I didn't have much opportunity to absorb the knowledge. Strangely enough, I managed to find a very difficult phrase. At the time, I thought I would surprise them, but I was the one who was surprised. They taught me not to be delusional about what I did and not to think I was the one who would succeed. At the time, I didn't realize it and still thought I would continue pursuing it. Now, the time to continue is over. Everything has fallen apart – youth, money, time, desires, etc. – gradually giving up. Returning to being an ordinary person is too late. Ultimately, I am a person with nothing, only illusions and fantasies. I only hope for one chance, for this to be the last time I have to chase knowledge for someone else. You can both exist and wait for opportunities, waiting to seize a particular phrase and then try your hand at it. But if the doors keep closing, then I'll take a different path. Because the sky is the limit.

Furthermore, I realize I'm someone who doesn't know my limits. I always try every way with the knowledge I have to do what I want to do. I'm stuck; with the knowledge I have, no matter how hard I try, I can't accomplish anything. I'm tired of that; I need a teammate. A team ready to train, train, train. Until you can no longer control your emotions. Then you'll see the fire burning in your heart.

To begin describing the breakdown of burning energy, let me delve into some theories and quote the formulas below.

First: According to the first law of thermodynamics, or the law of conservation of energy applied to thermal phenomena, energy is always conserved. In other words, the total energy of a closed system is constant. The events occurring within the system are simply the transformation of energy from one form to another. Thus, energy is neither created nor destroyed; it is always changing in nature. Throughout the universe, the total energy is constant; it can only be transferred from one system to another.

In other words: The change in internal energy of a system is equal to the sum of the work and heat received by the system: $\Delta U = A + Q$



Hình 2.1. Chu trình lý tưởng tổng quát của động cơ đốt trong a) Đồ thị p–V ; b) Đồ thị T–S.

Excerpt from the working cycle diagram in internal combustion engines by a professor and doctor Nguyễn Tất Tiến

To understand this graph, a basic understanding of the engine's operating cycle is needed. Adiabatic compression OC, isochoric heat supply CY, isobaric heat supply YZ, adiabatic expansion ZD, isochoric heat release DF, isobaric heat release FO

In this graph, the region from C to D represents the energy breakdown region or the combustion region of a gas mixture.

To analyze energy breakdown using the graph above, several thermodynamic equations would need to be combined to define the calculation region.

However, the first law of thermodynamics alone is sufficient to describe it. But how do we know how the heat supply function Q occurs in order to solve the temperature equation and find the instantaneous temperature?

So, what is temperature? From what I've read in some theories, temperature can be described by the root-square velocity, meaning that in an indeterminate gas system, because the speed of each molecule is different and extremely chaotic, it's impossible to accurately measure the velocity of a single particle, and even if it could, the number would be too large. So, the root mean square (or root mean square) temperature is used to describe the average velocity of a group of molecules in a gas region. So, once you have the average velocity of a group of molecules, what do you do next?

To move on, we'll consider molecular collision theory, which means that when given a set of particles a and a set of particles b, the temperature of the set neutralizes the energy of the particles, or in other words, one particle remains stationary and the other absorbs all the kinetic energy of the stationary particle. So, how many collisions occur in a second?

And how many collisions interact with each other, creating useful collisions, generating heat Q to make the mixture of particles a and b interact even faster or increase the temperature of the particle mixture? Furthermore, it can cause the particle mixture to deform, creating more useful collisions. The number of useful collisions depends on the activation energy of a compound, and the activation energy depends on its configuration, etc.

A series of events occurring in rapid succession creates combustion. It is also a series of terms derived from the phrase "release of molecular energy" at different temperature, pressure, volume, and concentration levels.

Based on the laws of thermodynamics, write the equations for points from C to Z.

We have:

$$Q_{cz} = U_z - U_c + L_{ci}$$

$$\Leftrightarrow U_z - U_c + L_{ci} = Q_{f(T)}$$

In there:

$$U_z = m_z(\overline{mC_v'}).T_z$$

$$U_c = m_c(\overline{mC_v}).T_c$$

$$L_{ci} = p_z V_z - p_i' V_i' = 8314(m_z T_z - m_i T_i)$$

Special:

$$Q_{f(T)} = Q_0.Z_i$$

In there:

Q_0 The basic thermal value of a molecule(J/mol)

Z_i Instantaneous useful collisions

$$Z_i = \sqrt{\frac{8kT_{i-1}}{\pi}} d_{AB}^2 . n_{A_{i-1}} . n_{B_{i-1}} . \frac{M_A + M_B}{M_A . M_B} . e^{-\frac{\Delta H_{i-1}}{R.T_{i-1}}}$$ (number of useful collisions of 1 cm³ in 1 second)

where K is the Boltzmann constant

n_a n_b number of molecules n_a, n_b = mol. Avogadro 6,0221415. 10^{23}

M_A M_B molecular weight

d_{AB} Molecular distance

T temperature in degrees °K

ΔH activation energy of the atom

In summary, we have the following general thermodynamic equation:

$$b''_v.T_i^2+\left(a''_v-8{,}314-b'_v.T_C\right).T_i+8.314.T_c-a'_v.Tc-Q_{f(T)}=0$$

A quadratic function is used to determine instantaneous temperature. To do this, an algorithm describing the resolution is needed.

i: Point notation over time

$f(T_i)$: Instantaneous temperature

$$b''_v.T_i^2+\left(a''_v-8{,}314-b'_v.T_c\right).T_i+8.314.T_c-a'_v.Tc-Q_{0.}\sum_1^i\left\{\left(\frac{8kT_{i-1}}{\pi}\right)^{\frac{1}{2}}d_{AB}^2.n_{A_{i-1}}.n_{B_{i-1}}.\frac{M_A+M_B}{M_A.M_B}.e^{-\frac{\Delta H_{i-1}}{R.T_{i-1}}}.\Delta t\right\}.\frac{1}{Ag}=0$$

.

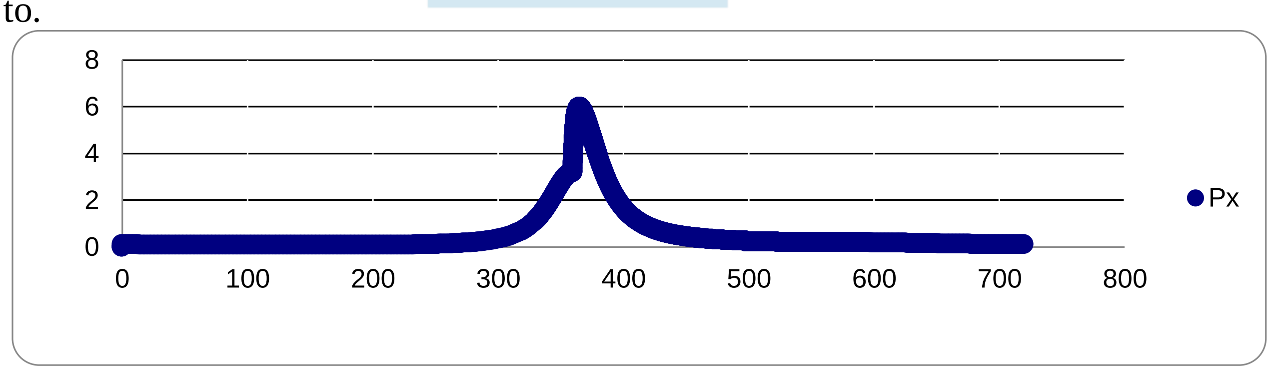
$$\Leftrightarrow b''_v.T_i^2+\left(a''_v-8{,}314-b'_v.T_C\right).T_i+8.314.T_c-a'_v.Tc-Q_{0.}\sum_1^i\frac{Z_i}{Ag}=0$$

where Ag is a constant Avogadro $6{,}0221415.\ 10^{23}$

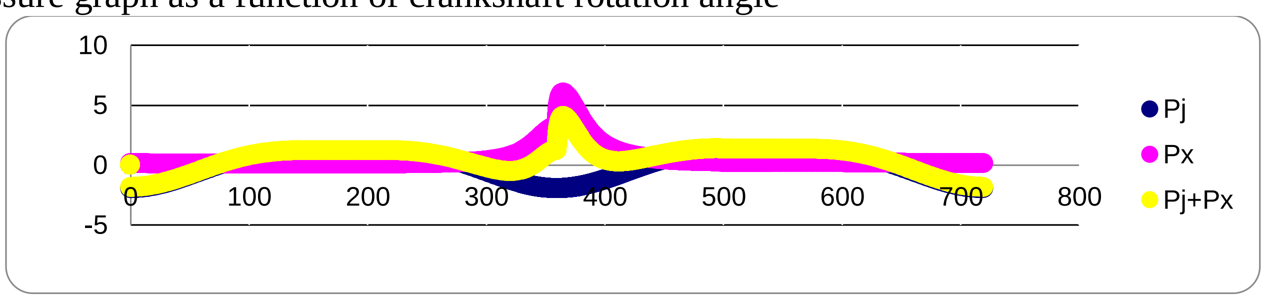
Most importantly for simulation $\lim_{\Delta t\to\frac{1}{c}}$; c speed of lightThis means that the smaller the time differential, the more accurate it is because the energy breakdown at a previous time point is a prerequisite for a later time point. Errors at a previous time point affect errors at a later time point. And the total error throughout the entire cycle is always desired to be the smallest.

Consider the collision at time i by taking the temperature T_{i-1} for consideration. Once the number of collisions Zi is determined, use the heat equation f(Ti) to find the value. T_i and so on until T_i to T_z is the completion of the combustion cycle. It's actually very complicated, because it involves programming self-add variables, and not just programming, but also physics theory.

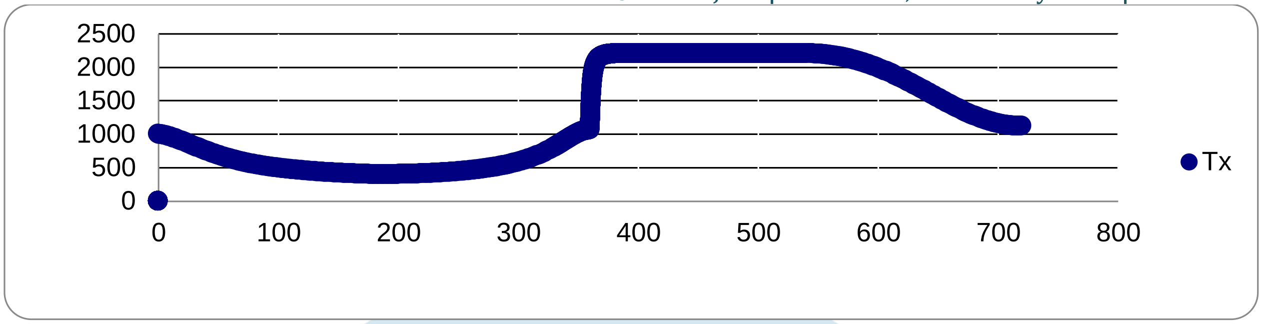
Let me summarize my understanding of the concept of combustion: When you burn something, you are giving it internal energy. The decomposition of that matter creates heat energy, increasing its temperature or internal energy. In a very short time, this increase in heat energy due to combustion continues until the amount of matter available to release heat energy is exhausted, preventing further increases in temperature. Eventually, there is no more matter left to.



Pressure graph as a function of crankshaft rotation angle



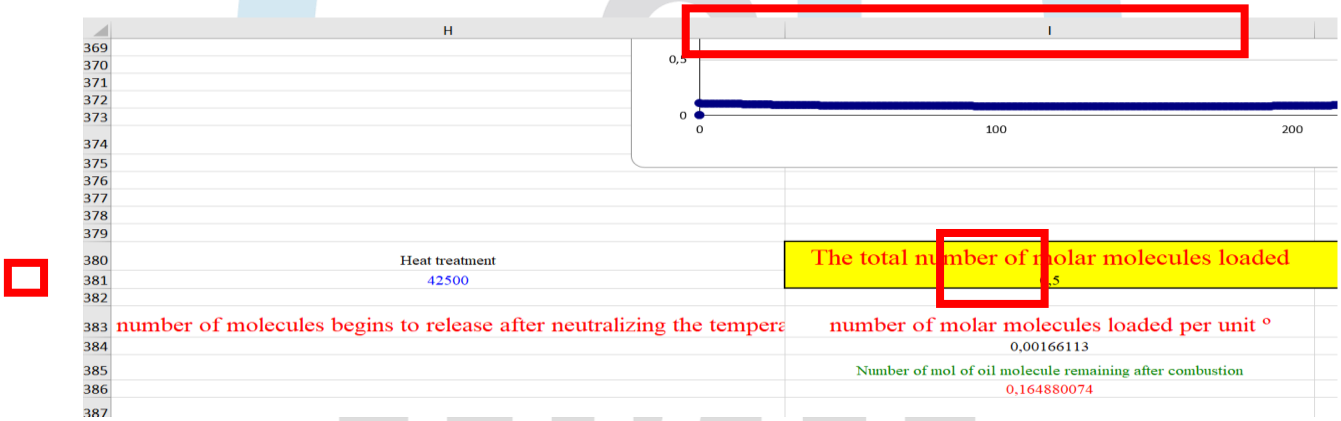
Work graph as a function of crankshaft rotation angle



Temperature graph as a function of crankshaft rotation angle

engine design.xlsx

Excel file simulating the combustion process for the engine design project.



Enter the number in cell I381; the Excel file will automatically calculate the combustion process based on the simulated energy input.

4.6 Discharge process

$$P_d = \frac{P_b.(V_c + V_h) - (V_h - V_{hi}).(P_b - P_o)}{V_h + V_c}$$

$$T_d = \frac{T_b.P_i}{P_d}$$

5. Limitations in the implementation process

The temperature of the flame during the isochoric process has been simulated, but the temperature of the flame during the expansion process has not yet been simulated.

More time and other researchers are needed to conduct in-depth research on the combustion process in internal combustion engines because the combustion process is too complex.

The combustion process has been simulated and proven to be consistent with theory, but it is not yet perfect.

6. Conclusion

Understanding the principles of fire in internal combustion engines is crucial because fire is used in many aspects of human life.

Discovering the principles of fire in internal combustion engines can help us optimize the combustion cycle, increasing engine power and reducing heat emissions into the environment.

The discovery of fire in internal combustion engines opens new avenues for research into engines as well as machinery and equipment that use fire as fuel.

7. References

Nguyên lý động cơ đốt trong của Giáo Sư Tiến Sĩ Nguyễn Tất Tiến