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Review: Future Scope in Mathematical Modelling of Pulse Combustor Suggested by Kilicarslan

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Abstract: ***Mathematical mechanical field produces versatile applications in very creative way. During past years of experience large range of mathematics applied in different field of mechanics for sustainable output. There are various modifications in combustor for the generation of oscillatory fluid motions or sound wave. Can different parameters solved by mathematics? Those are the focusing parameters in this review paper. We focus how first process of mechanical combustor is noisy? It can reduce in what amount of percentage. Is there any effect in vibrations and acoustics?***

Keywords: pulse combustor, kilicarslan

I. INTRODUCTION

The principal of pulse combustor is depending on the base of coupling between intermittent known as zero width waves and resonant known as acoustics with the combustor process this objective is defined in such a way that the output of intermittent having a huge amount of transformation of energy to the acoustical oscillations [The acoustical oscillations are periodic functions sin (wt+T0) or cos(wt+T0) where w=angular moment, t=resultant time and T0=Periodic time in the density of the visibility of pulse combustor]. The process for driven oscillations while combustion is known as combustion-driven oscillations is generally connected with instability of steady combustion process. This process is very risky but it gives higher heat transfer rate. Instability in combustion produces pressure waves and by which combustor may damage in future.

II. SIMPLE WORKING OF PULSE COMBUSTION WORKING

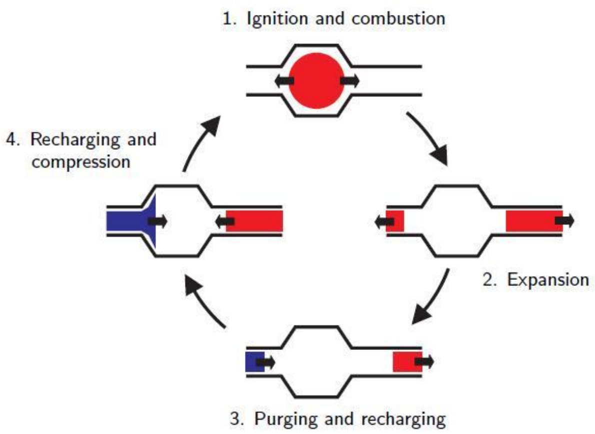

Figure 1: Schematic diagram of gas combustor [5]

Above image [5] describe the working function of pulse combustor. In first stage of cycle mixture in the combustion chamber become burn or ignites, this processed region will becomes expands for driving the mixture in burn formation into the tailpipe (to the right) with the aerodynamic valve.

Second stage, gives the responsive output of first stage. When almost all the mixture is in gas formation, the gases expands and cover the area of tail pipe and the aerodynamic

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valve, this stage is end of the gas transformation i.e. at the end of this stage pressure becomes lower compare with first stage in combustion chamber. After certain period of time, the pressure in the combustion chamber < that of the atmospheric pressure

In third stage Fresh air (and fuel) processed. This is entering into the combustion chamber. Due to inertia, the flow in the tailpipe takes reverse process compare with second stage and takes time for slowdown because of its reverse process.

Final stage, having ambient pressure cause of inertia of the gases is in bidirectional process at combustor chamber. Then, the cycle is started with new mixture and new liquidized combustor formation. And create one pulse at the end of four stages or one cycle.

III. RAYLEIGH MATHEMATICAL VIEW

As per Rayleigh criterion pulse combustor is nothing but a acoustical energy storage device. As per Rayleigh low pressure can be viewed as a refueling, while the acoustical oscillation sustain by periodic combustion and surveying energy to the resonator. That means this is applicable only under when periodic heat becomes release for sustaining acoustical oscillations. Means it states that acoustical oscillations are stirred when high temperature is at large in stage with the force variation, while the oscillations are damped when warmth is at large out of stage.

A. HISTORICAL VIEW

If heat up be occasionally communicated to, and inattentive from, a mass of air vibrating (for example) in a cylinder surrounded by a piston, the result shaped will depend upon the phase of the shaking at which the heat relocate takes place. If heat be known to the air at the instant of most concentration, or in use from it at the instant of utmost rarefaction, the shaking is confident. On the other side, if heat be known at the instant of greatest rarefaction, or distant at the jiffy of greatest abbreviation, the shuddering is dejected.

He also stated that,

If the air be at its normal density at the moment when the transfer of heat takes place, the vibration is neither encouraged nor discouraged, but the pitch is altered. Thus the pitch is raised, if heat be communicated a quarter period before the phase of greatest condensation, and the pitch is lowered if the heat be communicated a quarter period after the phase of greatest condensation. [4]

B. MATHEMATICAL VIEW

- ✓ Rayleigh defined how mathematically oscillations can be maintained.

$$\int_0^{Tp}\int_0^{V} p'Q'dV\,dt > 0$$ [6]

- ✓ where the double integration of period of oscillation (Tp: Period of time) and Volume air in combustor (V) over the product of the first derivative of pressure (gives fluctuations) p and the first derivative of fluctuations in heat release Q. This is nothing but a forward subsection moment argument of Rayleigh. That means, at the end of 4^{th} stage of combustor, air has sufficient energy to power up the engine with minimum loss. That is why order being used for reducing fraction loss and internal loss of combustor. (But some of the losses that being reduced not removed)

C. EQUATIONS

Above equation is, how much loss is accruing in volume over a period of oscillation.

$$\frac{\gamma-1}{\gamma p0}\int_0^{Tp}\int_0^{V} p'Q'dV\,dt > \sum_i Li$$ [6]

Suppose gas will process uniform and homogeneous state may be expressed as its velocity u0 = 0, pressure p = p0, density ρ=ρ0 and temperature T = T0, all constant.

In some assumptions, difference in pressure and volume becomes constant. It will effect on viscosity and heat conduction that what nullified i.e. introduce effect on all the parameters in which heat (Q'), velocity (u′), pressure (p′), density (ρ′) and Temperature (T′). Those disturbances are very small i.e. effects are judgmental. And finalized equation is:

$$\int_0^{Tb}\int_0^{V} p'Q'dV\,dt > \frac{\gamma p0}{\gamma-1}\int_0^{Tb}\int_0^{V}\phi'dV\,dt$$

D. SOME COMMON MISTAKES

- ✓ Energy fluctuation cannot be described.
- ✓ It should be greater or equals.
- ✓ 2^{ND} equation of Rayleigh analyze minimum amount of noise but sigma itself represents noise level.

Finalized graph of above equation compare with author's analytical graph (Vector graph Mathematical, Continuous graph Analytical)

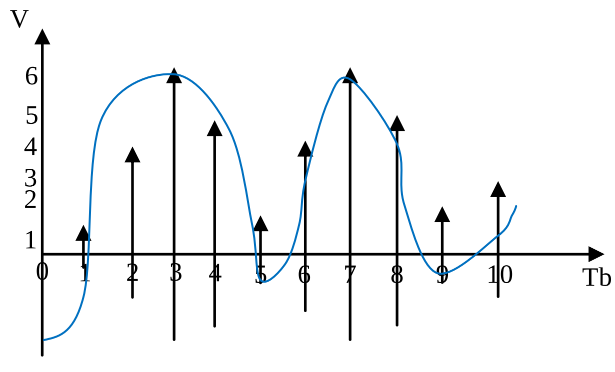

Figure 2: Comparative graph of performance of combustor

IV. KILICARSLAN MATHEMETICS AND MODEL

Kilicarslan suggestions with below graph

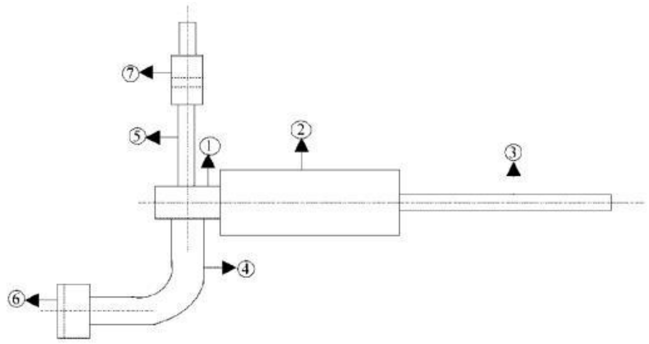

Figure 3: Model of Gas filled pulse combustor [5]

In fig. 3 graph is 1. Mixture head 2. Combustion chamber 3. Tail pipe 4. Air Supply 5. Gas Supply 6,7 Flipper Valves

- ✓ *Mixture Head:* Mix liquidized materials
- ✓ *Combustion Chamber:* An enclosed space in which combustion takes place, especially in an engine or furnace.[7]
- ✓ *Tail Pipe:* Object participated for expantion and compression
- ✓ *Air supply:* Provides air for thrusting liquidized materials.
- ✓ *Gas Supply:* Provides gas for thrusting liquidized materials.
- ✓ *Flipper Valve:* It can control the flow of gas.

A. MATHEMATICAL VIEW OF PROCESS

Ideal Gas flow is represented by: P=ρRT

Where P=Pressure (Pa), ρ=Density (kg/m^3), R=Specific gas constant (J/kgK), T=Temperature (K)

For ratio of specific heat γ is constant in ideal condition:

γ=Cp / Cv=Constant

Cp=Specific heat for constant Pressure (J / kgK)

Cv= Specific heat for constant Volume (J / kgK)

Now if ideal released heat is:

$$\frac{dQ}{dx} = \frac{dmr}{dx}\frac{\Delta Hf}{1+\gamma}$$ [6]

Practically heat transfer is (Modified Equation is):

$$\frac{dQ}{dx} = \frac{dmr}{dx}\frac{\Delta Hf}{1+\gamma} + Qn$$ (Author 1)

Delta H=Heat combustion of unit mass of fuel

Qn= Heat noise

$$\frac{dQ}{dx} = \frac{dmr}{dx}\frac{\Delta Hf}{1+\gamma} + Qn + Qm$$ (Author 1)

Qm= Material Loss

B. FOCUS POINTS

If delta H is constant for ideal condition means delta Hf becomes 0 means heat is not transferring. That point creates curiosity for ideal conditions of heat transferring.

C. PROBABLE SOLUTIONS

With considering both the points of Rayleigh as well as Kilicarslan equation may modify.

V. CONCLUSION

While introducing noise on system derivation of heat introduce one more parameter, at the end of one cycle gas efficiency becomes reduced due to gas absorption and no proper expansion at gas combustor. Overall practical efficiency of gas was 92.68 % at the end of one cycle.

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