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# Design, Analysis and Fabrication of Pulse Jet Engine

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***ABSTRACT***
*The pulsejet was the object of much concentrated study immediately after World War II, but in spite of this intense study, the pulsejet has never lived up to its promised performance. Recently, there has been a renewal of interest in the pulsejet and a considerable amount of research and experimentation has been conducted. Some recent developments are: pulsejets which are capable of supersonic operation, use of pulsejets for auxiliary power generation and attempts to use a pulsejet as a combustor for a gas turbine engine. This paper reviews this recent work and includes ideal combustion analysis, a description and working of the pulse jet. The problems of noise and vibration are also addressed. From this study of recent work, several potential applications are proposed, and recommendations about areas requiring further study are made.*

***KEY WORDS:*** *Pulse Jet Engine, Thermodynamic Analysis, Combustion Chamber, Nx-12.0.*

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## I. INTRODUCTION

Valve less pulsejet engines have no moving parts and use only their geometry to control the flow of exhaust out of the engine. Valve less pulsejet expel exhaust out of both the intakes and the exhaust, though most try to have the majority of exhaust go out of the longer tail pipe for more efficient propulsion. The valve less pulsejet operates on the same principle as the valved pulsejet, but the 'valve' is the engine's geometry.

Fuel, as a gas or atomized liquid spray, is either mixed with the air in the intake or directly injected into the combustion chamber. Starting the engine usually requires forced air and an ignition source, such as a spark plug, for the fuel-air mix. With modern manufactured engine designs, almost any design can be made self-start by providing engine with fuel and an ignition spark, starting the engine with no compressed air. Once the vehicle starts running, the engine only requires input of fuel to maintain a self-sustaining combustion cycle.

The pulsejet engine found a brief, but truly surprising and shocking application during World War II when the German V-l buzz bombs suddenly appeared over London in 1944. Since then, the pulsejet has largely been an engine of frustrated expectations even though several attempts have been made to develop this propulsion concept further. In the past few years new work has been initiated in this field, mostly outside of the United States. It is the purpose of the present report to review these activities and to assess the development potential of this fascinating, low cost propulsion device.

## II. LITERATURE REVIEW

**Bruce Simpson** reported in his book “The Enthusiast’s Guide to Pulsejet Engine”, that “He made a pulsejet engine of 55lbs by taking Lockwood’s design as reference and made some minor modifications to Lockwood’s design.

**Michel Kadenacy** who obtained a French patent for an engine utilizing the effect operation of a pulsejet engine. There are also European and US patents. In simple terms, the momentum of the exhaust gas leaving the cylinder of an internal combustion engine creates a pressure-drop in the cylinder which assists the flow of a fresh charge of air, or fuel-air mixture, into the cylinder. The effect can be maximized by careful design of the inlet and exhaust passages.

**Berthelot and Vieille and Mallard and Le Chatelier** discovered a combustion mode propagating at a velocity ranging from 1.5 to 2.5 km/s. This combustion mode arose when gas was ignited with a high-explosive charge.

Two French engineers, **Esnault and Peltrie**, patented a design for an engine that drove a turbine wheel. This engine worked based on the principle of two opposing pulsating combustion columns fitted in a single straight, tubular chamber working out of phase from one another.

## III. FABRICATION

The fabrication of the pulse jet considerably has no moving parts but certain parts of the pulse jet engine (Lockwood design) are the inlet nozzle, combustion chamber, U-tube and the tail pipe or exhaust. Each component here is made of mild steel as the mild steel is highly denser material and has greater thermal stability.

The density of mild steel is about 7850 kg/m3 and has a melting point of 1400°C, and easier to machine and is easily available at low cost the pulse jet engine is made in out mild steel and it also has a high resistance to breakage. Mild steel has low carbon content which in-turn gives high resistance to corrosion and alloying properties with other materials.

**Fig.1 Working model of the pulsejet engine**

## IV. WORKING OF VALVELESS PULSEJET ENGINE

The valve less pulsejet is not really valve less — it just uses the mass of air in the intake tube as its valve, in place of a mechanical valve. It cannot do this without moving the intake air outward, and this volume of air itself has significant mass, just as the air in the tailpipe does — therefore, it is not blown away instantly by the deflagration but is accelerated over a significant fraction of the cycle time. In all known successful valve less pulsejet designs, the intake air mass is a small fraction of the tailpipe air mass (due to the smaller dimensions of the intake duct). This means that the intake air mass will be cleared out of contact with the body of the engine faster than the tailpipe mass will. The carefully designed imbalance of these two air masses is important for the proper timing of all parts of the cycle.

When the deflagration begins, a zone of significantly elevated pressure travels outward through both air masses as a compression wave. This wave moves at the speed of sound through both the intake and tailpipe air masses. (Because these air masses are significantly elevated in temperature as a result of earlier cycles, the speed of sound in them is much higher than it would be in normal outdoor air). When a compression wave reaches the open end of either tube, a low pressure rarefaction wave starts back in the opposite direction, as if "reflected" by the open end. This low pressure region returning to the combustion zone is, in fact, the internal mechanism of the Kadenacy effect. There will be no "breathing" of fresh air into the combustion zone until the arrival of the rarefaction wave. The wave motion through the air masses should not be confused with the separate motions of the masses themselves.

At the start of deflagration, the pressure wave immediately moves through both air masses, while the gas expansion (due to combustion heat) is just beginning in the combustion zone. The intake air mass will be rapidly accelerated outward behind the pressure wave, because its mass is relatively small. The tailpipe air mass will follow the outgoing pressure wave much more slowly. Also, the eventual flow reversal will take place much sooner in the intake, due to its smaller air mass. The timing of the wave motions is determined basically by the lengths of the intake and main tube of the engine; the timing of mass motions is determined mostly by the volumes and exact shapes of these sections. Both are affected by local gas temperatures.

In the valve less engine, there will actually be two arrivals of rarefaction waves — first, from the intake and then from the tailpipe. In typical valve less designs, the wave that comes back from the intake will be relatively weak. Its main effect is to begin flow reversal in the intake itself, in effect "pre-loading" the intake duct with fresh outdoor air. The actual breathing of the engine as a whole will not begin in earnest until the major low pressure wave from the tailpipe reaches the combustion zone. Once that happens, significant flow reversal begins, driven by the drop in combustion zone pressure.

## V. THERMODYNAMIC ANALYSIS

### 5.1 Ideal Combustion

In order to examine the pulsejet it is necessary to establish a reasonable thermodynamic model. Such a model is closely approximated by the processes occurring in one of the first internal-combustion engines, the Lenoir engine j and thus the Lenoir cycle can be applied to the basic pulsejet tube. The Lenoir engine is a two-stroke piston engine without pre compression .This engine takes in a stoichiometric fuel/ air mixture during the first half of the downward piston stroke; halfway through the stroke the intake valve is closed and ignition occurs.

The piston speed is at a maximum during ignition, but for our present discussion we will assume instantaneous combustion which is then a constant volume process. The combustion products expand during the second half of the stroke and produce mechanical power. The gases are exhausted during the upward stroke against a back pressure. The engine has no clearance volume and the back pressure does not impair the volumetric efficiency during the next intake stroke. Since the Lenoir engine takes In a fuel/air mixture at a low pressure and discharges the combustion products at a higher pressure, it can be used as a pressure generator. Proper timing of the spark will make the pressure at the bottom of the power stroke equal to the back pressure to prevent throttling losses. It continues to run if there is enough amount of fuel and can produce thrust that can propel at a rate of speed of sound.

The procedure that carries out in a pulse jet engine during the thrust production is as follows,

1) Intake
2) Constant volume combustion
3) Isentropic expansion of combustion products
4) Exhaust at constant pressure
5) Valves open and a new cycle start.

## 5.2 Performance Analysis

The ideal thermodynamic cycle of pulse jet is shown in figure. It consists of two reversible adiabatic processes, one reversible isochoric process and one reversible isobaric process. It is assumed that air is the only Working fluid and let 1kg/s is the fixed mass of air undergoing the cycle of operations as described below. In the cycle, air is compressed partially in the process 1-2 reversibly and adiabatically. Heat is then added to air reversibly at constant volume in process 2-3. Work is done by expanding air reversibly and adiabatically in process 3-4.

Heat is rejected by air reversibly at constant pressure in process 4-1, and the system (air) comes back to its initial state.

Let,

T1 be the initial inlet temperature of air having corresponding Pressure P1,

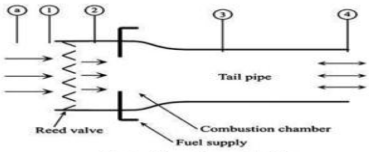
T2, P2 be the temperature and pressure respectively of the air after heat addition,

T3, P3 be the temperature and pressure of air after expansion in tail section and

T4, P4 be the temperature and pressure of air after heat loss.

In the P-V diagram, area enclosed by points 12341 represents the work done in one complete cycle. And the letters surrounded in circle are used to calculated work done in a cycle. Work done is equal to area represented by "c" minus area of represented by and "a" and "b" together.

Ƞ= net work done/heat supplied



Operation of a pulsejet

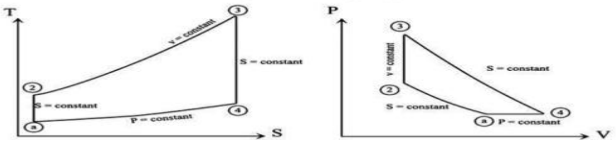


**Fig.2 P-V T-S graph of a pulsejet engine**

## VI. DESIGN OF VALVELESS PULSE JET (LOCKWOOD DESIGN)

### 6.1 2-D SKETCH

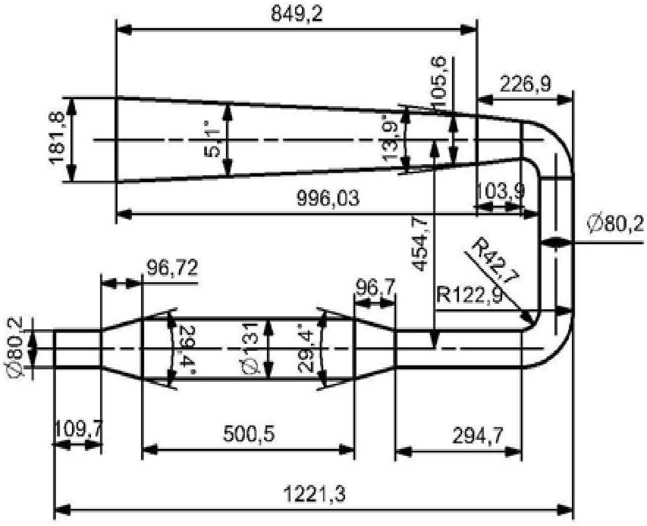


**Fig.32-D Sketch of pulsejet engine**

### 6.2 3-DSKETCH

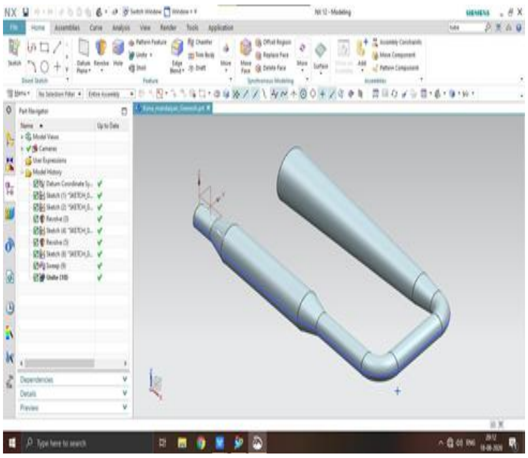


**Fig .4 3-D model (NX-12.0 Window Mode)**

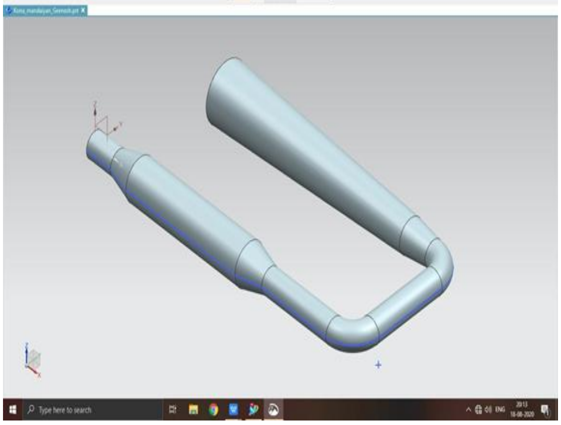


**Fig .5 Isometric view of the pulsejet engine**

## VII. CONCLUSION

Valve less Pulsejet Engine was fabricated and its performance was studied. In present work, thrust power at various fuel supply rates was calculated and it was found that thrust power is increasing linearly with increase in fuel flow rate. Various losses such as heat loss through exhaust gases, heat loss through Convection and Radiation were calculated and furnished in the form of heat balance sheet.

From analysis, it is clear that heat loss through exhaust gases is very high when compared to any other heat loss. So, to obtain more thrust power, heat loss through exhaust gases has to be minimized. Though noise and vibrations are common in any engineering device, this engine is producing much critical noise and vibrations which are beyond the limit. Making some modifications to the design and adding some components absorb vibrations may bring good results**.**

One possible reason that early pulsejets have not lived up to their potential is that the development of a mathematical model of a pulsejet is extremely complex and even today an entirely adequate theoretical study has never been completed. But construction of a pulsejet is a relatively simple task and therefore many have been built without sufficient knowledge of the effects of the many parameters.

## REFERENCES

[1] The Pulsejet engine, A review of its development potential by John Grant O'Brien, June 1974.
[2] HussainSadigHussain- Theoretical and Experimental Evaluation of Pulse Jet Engine, 2008.
[3] G.D.Roy, Pulse Detonation Propulsion: Challenges, Current Status and Future Perspective, http://www.elsevier.com/locate/pecs, 2004.
[4] Robert Lewis Ordon, Experimental Investigations into the Operational Parameter of a 50 Centimeters Class Pulse Jet Engine, North Carolina State University, 2006.
[5] Colin Furze – Big Pulse Jet Project, http://www.colinfurze.com/big-pulse-jet-project.html, 2012.
[6] Shashank Ranjan Chaurasia, Rajesh Gupta and R.M. Sarviya - "Performance Analysis of a Pulsejet Engine", 2013.
[7] Karthick Raja R. Rio Melvin Aro.T. Shyam Shankar. M. B. Vinoth. - "Design and Optimization of Valve less Pulsejet Engine", 2014