Conceptual Development of non-conventional steam turbine

By

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Dissertation submitted in partial fulfillment of
The requirements for the
Bachelor of Engineering (Hons)
Mechanical Engineering Department

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Supervised by AP. Dr. Syed Ihtsham Ul-Haq Gilani

CERTIFICATION OF APPROVAL

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My appreciation is also extended to my family, my friends and everyone who encouraged and supported me throughout the project.

ABSTRACT

The quest of searching for new sources of energy has been motivated by both economic and political reasons. This made the industry look into resources that were overlooked before. Steam engines show a promising future of generating electricity off the gird.

However, the conventional steam turbine's power conversion efficiency of is 20% to 38%. A conventional steam turbine that has conversion efficiency over 60% does not exist. 2/3 of the energy is wasted in the conversion cycle. Most of the wasted energy comes out as low pressure steam at the outlet of the turbine. Therefore in this research a new concept steam engine will be designed to convert the low pressure steam into useful mechanical energy or work.

This project aims to create a CATIA simulation model of the new conceptual design of the green steam engine. These types of engines are more efficient than the ancient steam engines, because simply the Flex Rod mechanism and the "Z" drive replaces the standard bell crank which leads to straight line, intermittent movement that eliminates side forces. Those side forces has a great contribution in the friction force during the operation of the conventional steam engines

After creating the model, an excel sheet was made to determine the power output of the engine with the ability to simulate using different these parameters.

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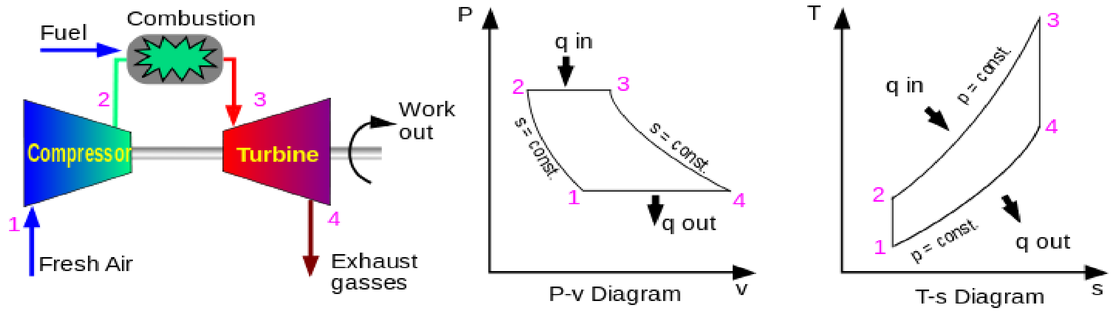
CHAPTER 1

INTRODUCTION

1.1 Background Study

The steam engines are widely known as the most important invention throughout the entire industrial revolution. In all parts of industries nowadays the concept of the steam engine is used. During the 17th century the practical uses for the steam started to rise. It is well known that the credits of using the steam engines are given to James Watt and Thomas Newcomen. Numerous scientists, engineers and even writers contributed a lot in the steam engine invention, the steam engine was a result of the compilation of work and theories and it took centuries to complete.

The usage of the steam for the advantage of the mankind goes back nearly twenty-one centuries. An ancient writer named Hero from Alexandria wrote some manuscript explaining and showing different devices and ideas about the usage of steam power of that time. Even though it couldn't be proven that the inventor of these devices was hero. Hero was given credit for the earliest mention of the steam power concept. He described, in one of his manuscripts, a way to open the doors of a temple using fire action on the Alter placed at the entrance of the temple. A series of pipes were constructed to force the steam created by the Alter to reach the temple doors and if it is strong enough it will open the temple doors. Hero's essential principle was the conversion of the heat energy into mechanical energy or work in other definitions.



(a) Schematic diagram (b) P-V diagram of Rankine cycle (c) T-s diagram of Rankine cycle

Figure 1.1: Rankine cycle [5]

In a real power plant cycle (the name 'Rankine' cycle is used only for the ideal cycle), the compression by the pump and the expansion in the turbine are not isentropic. In other words, these processes are non-reversible and entropy is increased during the two processes. This somewhat increases the power required by the pump and decreases the power generated by the turbine.

In particular the efficiency of the steam turbine will be limited by water droplet formation. As the water condenses, water droplets hit the turbine blades at high speed causing pitting and erosion, gradually decreasing the life of turbine blades and efficiency of the turbine. The easiest way to overcome this problem is by superheating the steam. On the Ts diagram above, state 3 is above a two phase region of steam and water so after expansion the steam will be very wet. By superheating, state 3 will move to the right of the diagram and hence produce a drier steam after expansion.

1.2 Problem Statement

The conventional steam turbine's power conversion efficiency of is 20% to 38%. A conventional steam turbine that has conversion efficiency over 60% does not exist. 2/3 of the energy is wasted in the conversion cycle. Most of the wasted energy comes out as low pressure steam at the outlet of the turbine. Therefore in this research a new concept steam engine will be designed to convert the low pressure steam into useful mechanical energy or work.

1.3 Objectives

1- To study the thermodynamics properties of conventional and non- conventional steam turbines

2- To design and create animation of a non-conventional steam engine that converts the low pressure steam at the outlet of the turbine.

3- To simulate different quality steam and calculate the difference in the efficiency of the steam engine.

1.4 Scope of the study

The research will cover an experiment of designing, creating animation then simulating the steam engine. The design will consist of a steam engine that runs on the low pressure steam at the outlet of the conventional steam turbines to increase the efficiency of the turbine.

This project will focus on obtaining the highest efficiency possible by reusing the low pressure steam at the outlet and building a working prototype for the steam engine.

CHAPTER 2

LITERATURE REVIEW

2.1 Steam Turbines

Steam turbines are one of the oldest technologies which has been used to generate electricity by converting the heat energy into mechanical energy or work since they took over by replacing the reciprocating steam engines, because steam turbines has higher efficiency and does not cost as much as the reciprocating engines. Steam turbines capacity has a range of 50 KW to several hundred MWs depending on the size and the usage of the turbine.

The steam turbines are not capable of converting the fuel into electric energy directly. The fuel must be used to create a high pressure steam that is used to power the turbine which leads into the power of the generator. Different types of fuel can be used to operate the turbine varying from clean natural gas to solid waste, including all types of wood, coal, wood waste and agricultural byproducts. The outlet of the turbine produces lower pressure steam which in this experiment will be used to run a steam engine to increase the efficiency by reusing the wasted steam power.

2.2 Types of Steam Turbines

2.2.1 Non-Condensing (Back - pressure) Turbine

This type of steam turbines which is known as the back - pressure turbine or the non-condensing turbine, the turbine has 1 input of high pressure steam and 1 output of low pressure steam the high pressure steam is causing the turbine blades to rotate causing the power of the generator leading to the output power.

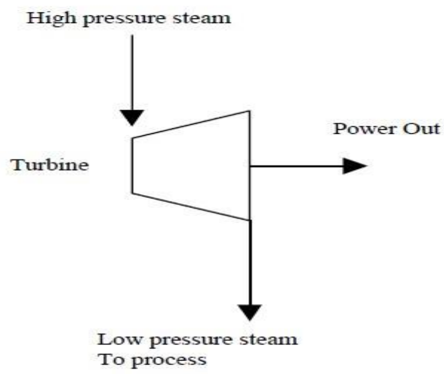


Figure 2.1: Non-Condensing (Back - pressure) Turbine [9]

2.2.2 Extraction Turbine

This turbine is known as the extraction turbine, this type of turbines has 1 input of high pressure steam and 2 outputs for intermediate pressure steam and low pressure steam. The intermediate pressure can be used for CHP facility, or for feed-water heating which is used in most of the utility power plants.

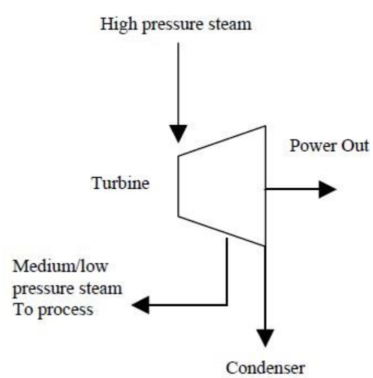


Figure 2.2: Extraction Turbine [9]

For this design, The Back-Pressure turbine will be used to power the steam engine as it produce more low pressure steam which can increase the operating power of the steam engine.

2.2.3 Impulse turbines

An impulse turbine has fixed nozzles that orient the steam flow into high speed jets. These jets contain significant kinetic energy, which is converted into shaft rotation by the bucket-like shaped rotor blades, as the steam jet changes direction. A pressure drop occurs across only the stationary blades, with a net increase in steam velocity across the stage. As the steam flows through the nozzle its pressure falls from inlet pressure to the exit pressure (atmospheric pressure, or more usually, the condenser vacuum). Due to this high ratio of expansion of steam, the steam leaves the nozzle with a very high velocity. The steam leaving the moving blades has a large portion of the maximum velocity of the steam when leaving the nozzle. The loss of energy due to this higher exit velocity is commonly called the carry over velocity or leaving loss.

2.3 Maintenance

Steam turbines are very rugged units, with operational life often exceeding 50 years. Maintenance is simple, comprised mainly of making sure that all fluids (steam flowing through the turbine and the oil for the bearing) are always clean and at the proper temperature. The oil lubrication system must be clean and at the correct operating temperature and level to maintain proper performance. Other items include inspecting auxiliaries such as lubricating-oil pumps, coolers and oil strainers and checking safety devices such as the operation of over speed trips.

In order to obtain reliable service, steam turbines require long warm up periods so that there are minimal thermal expansion stress and wear concerns. Steam turbine maintenance costs are quite low, typically around $0.005 per kWh. Boilers and any associated solid fuel processing and handling equipment that is part of the boiler/steam turbine plant require their own types of maintenance.

One maintenance issue with steam turbines is solids carry over from the boiler that deposit on turbine nozzles and other internal parts and degrades turbine efficiency and power output. Some of these are water soluble but others are not. Three methods are employed to remove such deposits:

1) Manual removal

2) Cracking off deposits by shutting the turbine off and allowing it to cool

3) For water soluble deposits, water washing while the turbine is running.

2.4 Green Steam Engine

The steam engine main concept, it operates on the low pressure steam to convert heat energy into mechanical energy using the pistons, these pistons create a wavy motion which can be converted into a rotational motion to operate a generator to produce electricity

These types of engines are more efficient than the ancient steam engines, because simply the Flex Rod mechanism and the "Z" drive replaces the standard bell crank which leads to straight line, intermittent movement that eliminates side forces. those side forces has a great contribution in the friction force during the operation of the conventional steam engines, by using the Flex Road Mechanism also other parts can be eliminated from the steam engine as the crosshead, wrist pin and bearing, heaving piston rod and bearing, long and heavy pistons with metal rings, and the piston rod seal at the base of the cylinder. The elimination of these parts will cause a massive loss in the friction force caused during operating.

Other characteristics of the green steam engine which cause increase in the efficiency is that the cylinders are easily insulated to prevent heat loss, the materials used for the cylinders can be molded insulating material suck as glass or high temp carbon fiber.

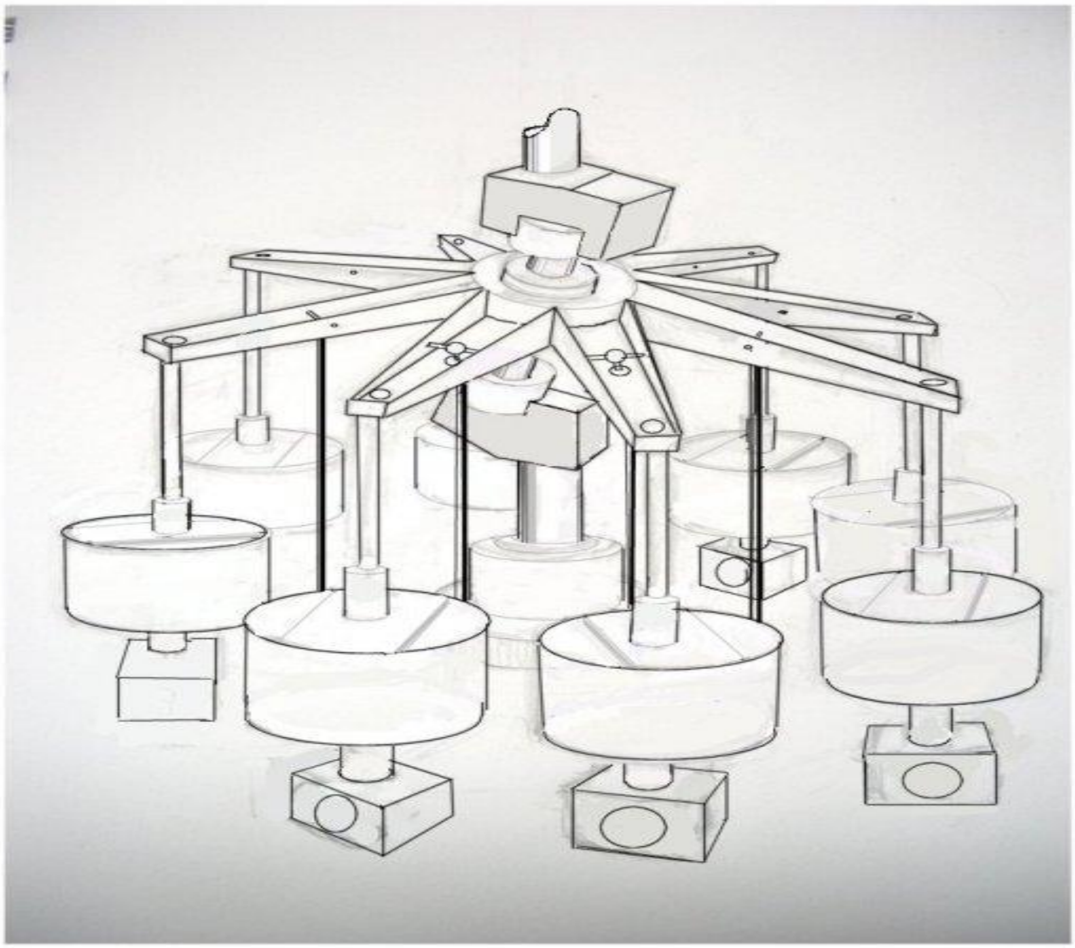


Figure 2.3: Green Steam Engine [10]

Here are a few reasons to consider steam engines as an alternative to other systems.

- Steam engines can run 24 hours a day regardless of location, weather or daylight.
- There are no construction costs, towers, roof panels or permits required.
- There is no noise or environmental impact associated with steam power.
- The Green Steam Engine may be powered by the widest range of alternative fuels, including solar and geothermal.
- No back-up power required as it is for wind and solar systems.

Unlike internal combustion engines that need high rpm's to develop full power, steam engines have full power at starting speed. Windmill generators operate at low rpm's (100 to 600 rpm's). Although steam engines can run at high speeds, to do so requires more steam volume than necessary. It is much more economical to run them slowly. For electrical generation, use the same electrical system as you would for windmills.

Green Steam Engine Advantages:

- Runs on very low steam pressure and low volume (freewheels at 2 psi),
- Costs little to build,
- Nearly zero lubrication requirements,
- Can be assembled or disassembled in minutes,
- Extremely lightweight,
- Few moving parts,
- Boiler requirements are minimal,
- Can run in any position like an electric motor.
- Very small profile for economy of space.
- May be variably configured for desired power vs. speed requirements.
- Utilizes modern materials and methods previously not applied to steam power.
- Highly versatile and elegantly simple.

The properties of the crank mechanism (called a "flexible rod transmission") invented by Robert Green, provides this engine with the advantage of eliminating the typical crankshaft and cam that requires lubrication and precision machining. It also provides the unique configuration whereby the cylinders are aligned in the same direction as the main shaft. The result is a compact, lightweight and slim engine that is extremely simple to construct and assemble.

The pistons and valves operate off a short piece of flexible shaft. Because the flexible shaft is fixed and cannot rotate, the piston rods and valve push rod are held in position while being reciprocated. The cylinders float, attached to a swivel ball fitting at their base. Much of the structure and weight of a typical steam engine has been eliminated.

The unique feature of the "Flex Rod Transmission" is that it produces an intermittent movement whereby the valve movement is stopped in its open and closed position during the power and exhaust strokes. This gives prolonged, fully opened valve timing. In compliment, the pistons are held stationary while the valve moves between phases. The output shaft continues rotation while the pistons stand still. The result is that the efficiency is increased dramatically. The overall friction of the engine is reduced due to the small number of light weight moving parts, and the use of ball bearings throughout. The flex rod is nearly frictionless as the flexing is like a spring in which the energy required to flex it is returned in equal amounts.

This engine may be made in a variety of configurations and sizes. For example, one can change piston size and stroke length in a matter of a couple of minutes. One cylinder may be substituted for an air pump cylinder to provide air or water pumping. It can have one or a plurality of cylinders without increasing the number of bearings.

This engine can power a boat, a generator, air pump, water pump, heating blower, water distiller, heat pump, air conditioner, model airplanes, boats and trains or a variety of appliances with any fuel that will heat water including solar and geothermal. Waste heat from engines or manufacturing processes may also be used to generate steam to power this engine. Because it is so lightweight and compact, it could be used in vehicles to run pumps on waste heat; saving power and fuel. This powerful, quiet engine is a breakthrough in alternative energy use. Because of a revolutionary new patented means of converting reciprocating movement into rotary movement, the "Green Steam Engine" has dramatically simplified the piston engine.

CHAPTER 3

Methodology

The research intends to design, simulate and manufacture of a steam running on the wasted low pressure steam wasted from conventional turbines, after finishing the simulation the steam engine will be tested under different condition with different quality steam to test the amount of output power and increase in the efficiency of the turbine.

3.1 Gantt chart/Milestones

Table 3.1: Gantt chart with key milestones for FYP1

DEATIL/WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Selection Of Project Topic														
Preliminary Research Work on Steam Turbines and Steam Engines														
Submission of Extended Proposal														
Proposal Defense														
Steam engine Design complete														
Completion Of Interim Report														
Submission of Interim Report														•

Table 3.2: Gantt chart with key milestones for FYP2

DEATIL/WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Engine Development														
Fabrication						●								
Testing different quality of steam														
Result Analysis														
Final Report												●		

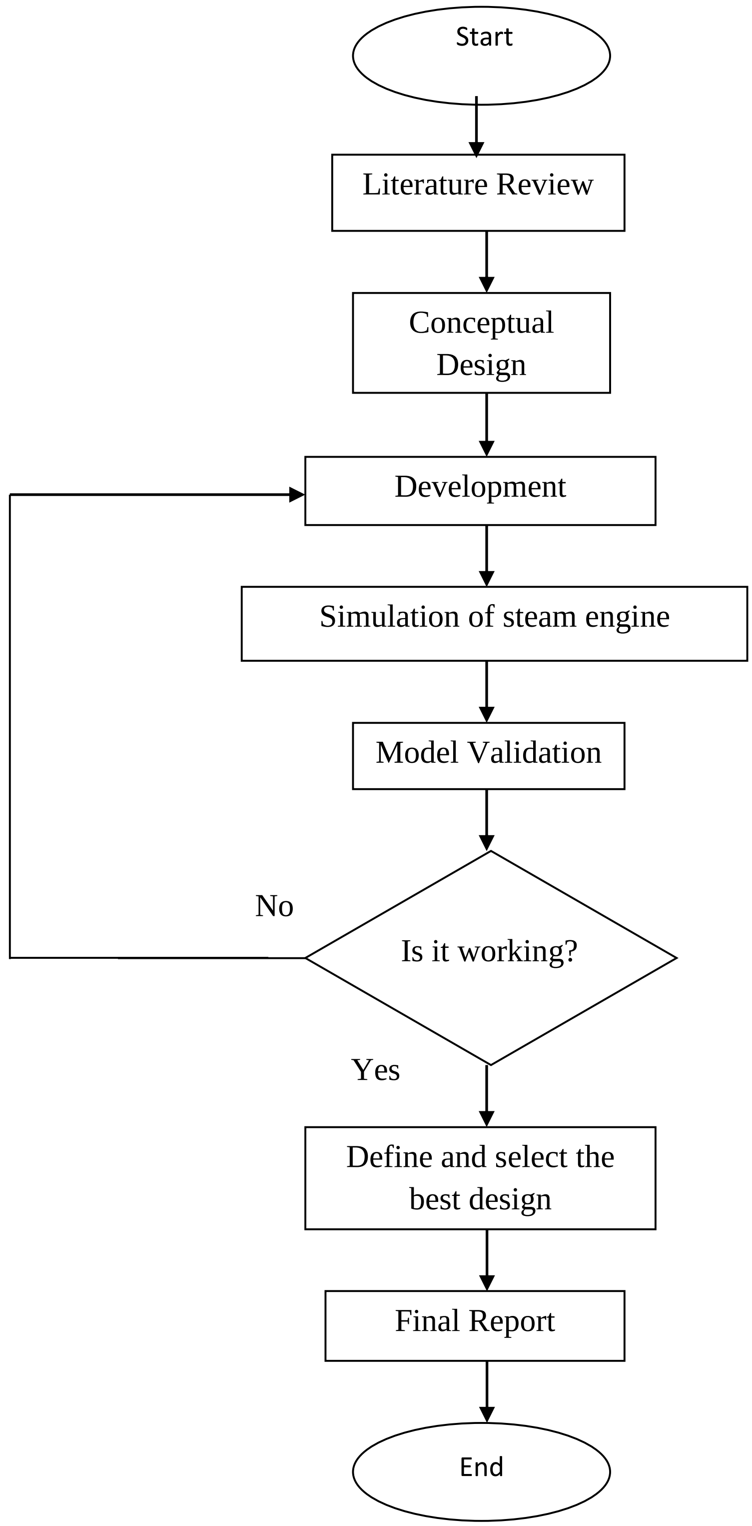


Figure 3.1: Flow Chart of Work plan

CHAPTER 4

RESULTS AND DISCUSSION

DISCUSSION

After modeling the green steam engine using CATIA software, some modifications have been made to the design such as replacing the Z mechanism or the Flex Rod mentioned in the previous chapters to a spherical joint with 3 degree of freedom which led to less friction forces inside the engine and the manufacturing process became easier using the cam mechanism to control the steam valves. The benefits of the new design are:

1. Simple conversion from rotary to reciprocal movement and vice-versa.
2. Multiple outputs from a single rotary source.
3. Multiple outputs with separate timing, amplitude and duration.
4. Input and output in same linear direction.
5. Extremely simple structure.
6. Few and easily constructed parts
7. Little or no lubrication requirements
8. Applications include generators, distillers, boat propulsion, pumps, toy models, to suggest only a few.
9. Engine may be operated on any fuel including solar, bio-mass, dung, corn and barley, wood, waste heat and unrefined fuels.

Besides the extreme economy of structure, the properties of spherical joint provide this engine with the advantage of eliminating the typical crankshaft and valve mechanisms that require heavy cast parts and precise machining. It also provides the unique configuration whereby the cylinders are aligned in the same direction as the main shaft. The result is a compact, lightweight and slim engine that is extremely simple to construct and assemble. The green steam engine can approximately produce about 10 HP at 125 psi. 4.5 hp at about 50 psi and 2.5 at 30 psi.

4.1 The Physical Concept

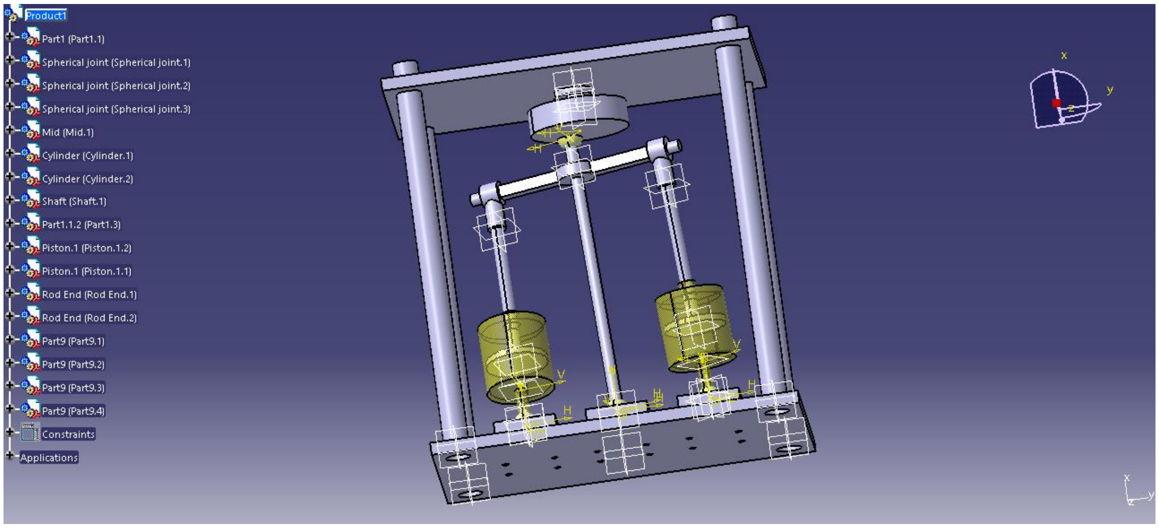


Figure 4.1: 2 Cylinder engine CATIA simulation

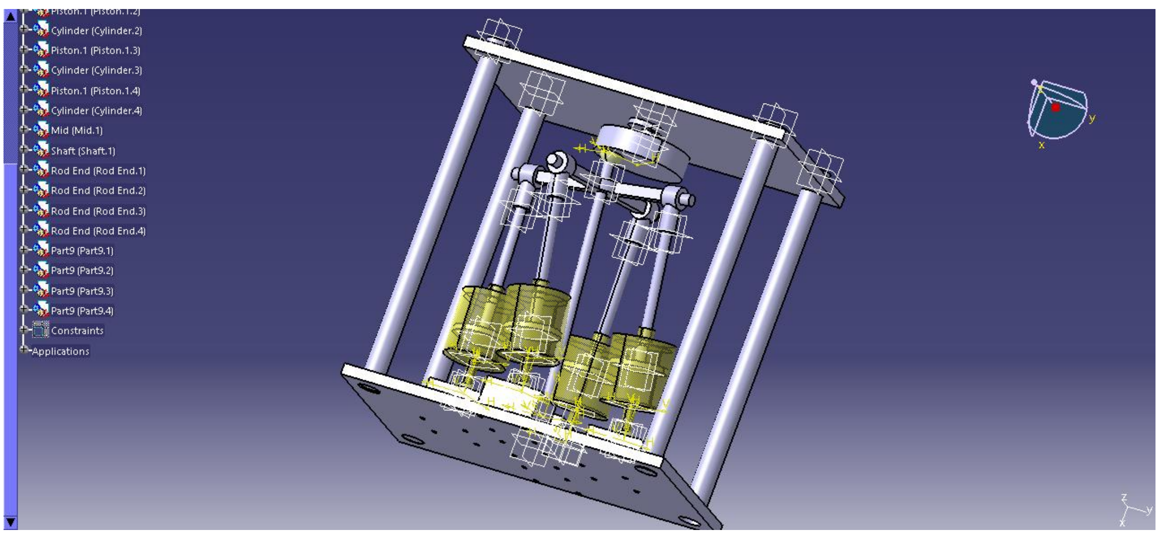


Figure 4.2: 4 Cylinder engine CATIA simulation

The 2 cylinder engine construction is shown in figure 4.1, it shows the concept of using the spherical joints to replace the typical crankshaft, Z mechanism or the flex rod and also it shows the simplicity of the engine compared to the other conceptual designs in the previous chapters, the current engine design is compact, lightweight and slim because it has dimension 40 x 60 x 62 cm only and the arrangement, whereby the cylinders are in the same plane as the main shaft permits large engines to occupy a very small and compact space.

Figure 4.2 shows the CATIA simulation of the 4 cylinders version of the green steam engine where 4 pistons are operating in sequence to generate the power output

4.2 Critical Components

The following is a list of critical components found in the green steam engine:-

4.2.1 Piston

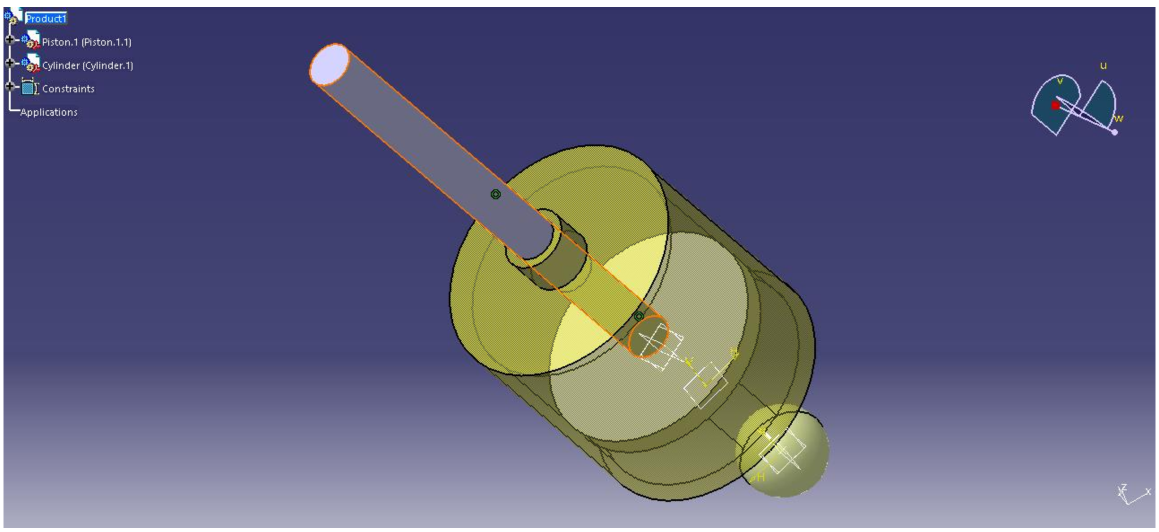


Figure 4.3: Piston (CATIA simulation)

As mentioned earlier, the piston is unique from the perspective that it has a spherical joint with only 3 degree of freedom that allows the piston to move with the shaft movement

Inner diameter = 5 cm

Outer diameter = 5.5 cm

Height = 10 cm

Material: copper

Operating PSI: 20-200

4.2.2 Rod Ends and Crankshaft

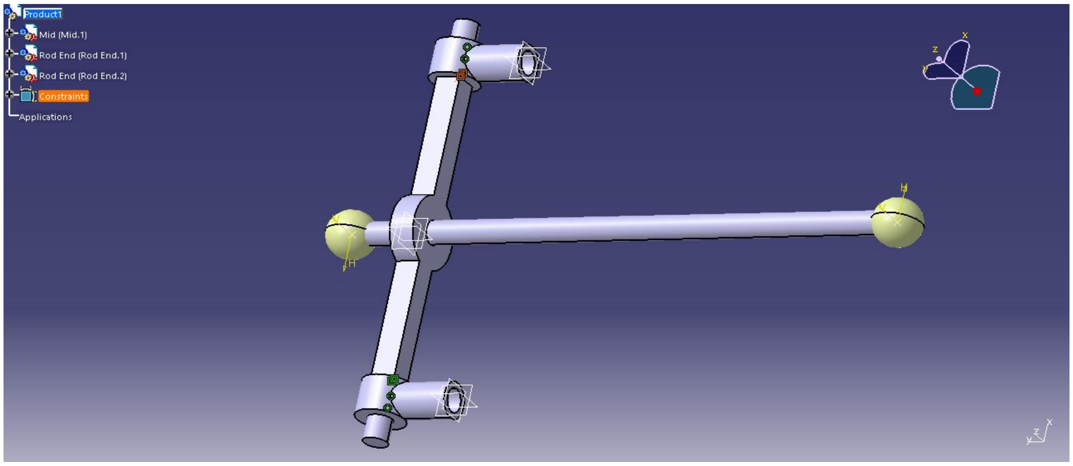


Figure 4.4: Rod Ends and Crankshaft

Figure 4.4 shows the new 2 spherical joints replacing the flex rod to produce a more flexible crankshaft connected to the rod ends pushing in sequence by the 2 steam pistons to create the wave motion inside the engine, the bottom spherical joint will be connected and fixed to the base, the upper spherical joint is connected to the head and cam to produce the rotary motion to generate electricity and producing the cam movement as well to control the steam supplying the two pistons

4.2.3 Head and Cam

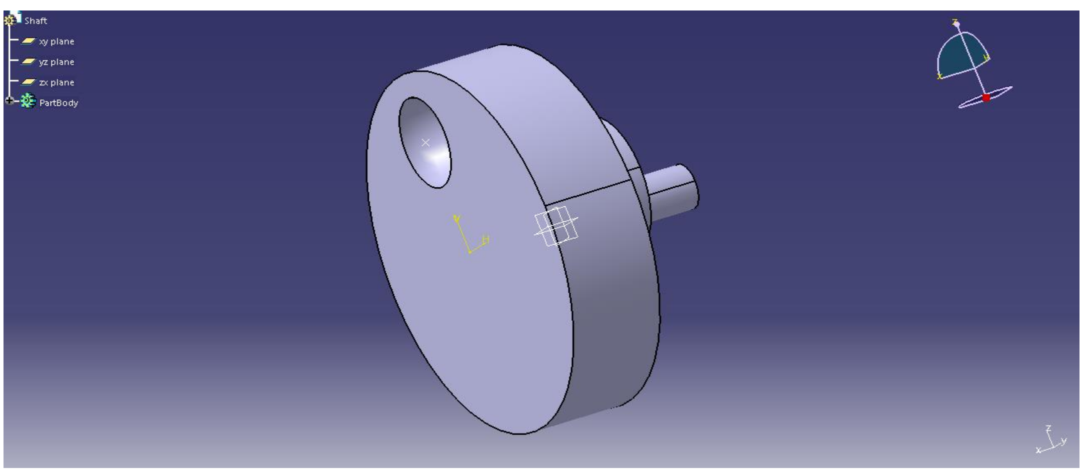


Figure 4.5: Head part

The head part showed in figure 4.5, the spherical joint is used to change the wavy motion into a rotary motion rotating the head to supply the electrical generator to generate electricity.

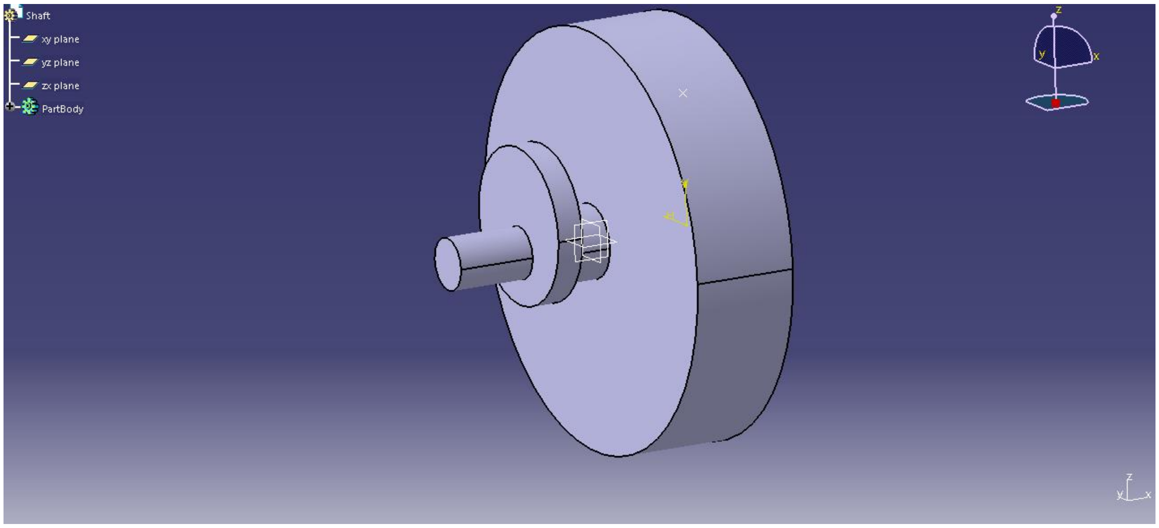


Figure 4.6: Head Cam

Figure 4.6 shows the head cam which is used to drive valves to control the steam inlet and exhaust inside the pistons, two valves with springs will be connected from opposite sides to the cam

4.3 Power Output

Fundamental parts of the steam piston engine are the pistons with piston rod inside cylinder and steam distribution unit that drive the entering and the exhausting of steam from the cylinder. This force makes work through move of the piston. The work is distributed as a torque:

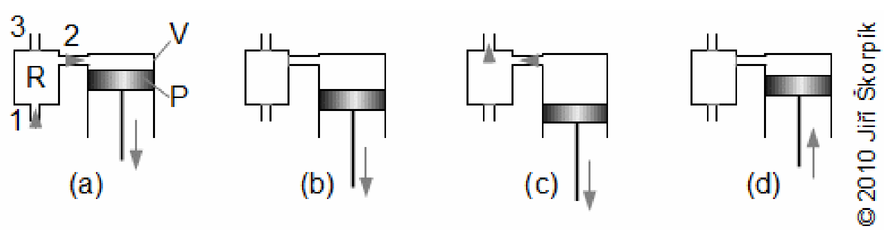


Figure 4.7: Work cycle of the steam piston engine.

The work cycle of the steam piston engine has four events:

- The admission: High pressure steam flows through the distribution unit into the cylinder, Figure 4.7a (the inlet of steam into the cylinder (2) is open; the exhaust of steam (3) from the distribution unit is closed.
- The expansion: Steam expands inside the cylinder (decreasing of pressure and increasing of volume), Figure 4.7b (the inlet of steam into the cylinder (2) is closed).
- The exhaust: Low pressure steam flows through the distribution unit from the cylinder to the exhaust, Figure 4.7c (the inlet of steam in the distribution unit (1) is closed).
- The compression: Compression of Steam inside the cylinder, Figure 4.7d (the exhaust from the cylinder (2) is closed).

The start respectively the end of a cycle event is called distribution point. A scatter of the distribution points in work cycle has a major impact on work of an engine and steam consumption, because they define duration of the events.

Steam engines and turbines operate on the Rankine cycle which has a maximum Carnot efficiency of 63% for practical engines, with steam turbine power plants able to achieve efficiency in the mid 40% range.

The efficiency of steam engines is primarily related to the steam temperature and pressure and the number of stages or expansions. Steam engine efficiency improved as the operating principles were discovered, which led to the development of the science of thermodynamics

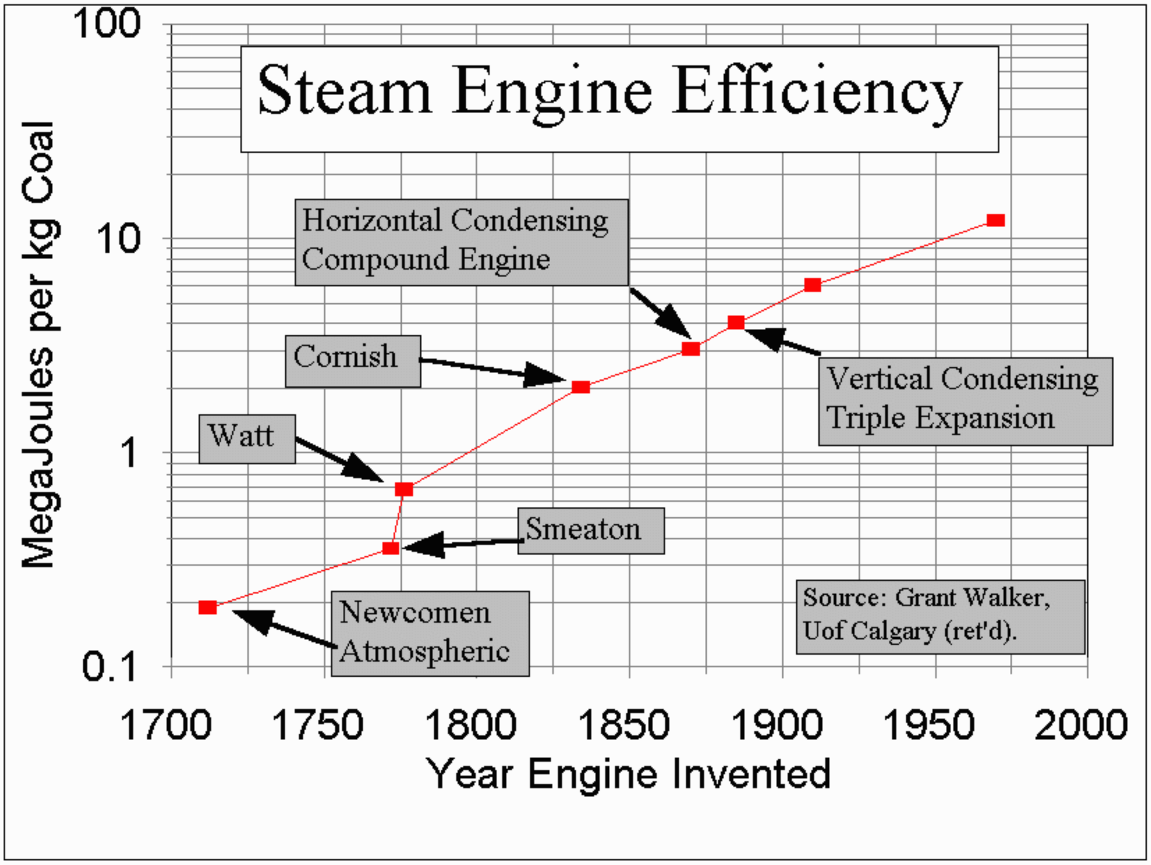


Figure 4.8: Steam Engine Efficiency Graph [6]

In earliest steam engines the boiler was considered part of the engine. Today they are considered separate, so it is necessary to know whether stated efficiency is overall, which includes the boiler, or just of the engine.

The formula used to calculate the power output of the green steam engine is

$$Horse\ Power = {}^{P \times S \times A \times N}/_{3300}$$

P = Steam Pressure

S = Piston Stroke in inches (1/2 to 3/4 of piston diameter)

A = Area of Piston (Pi R squared)

N = Number of RPMs * Number of Cylinders

Using the following conditions, P = 100 , S =1.476, A=3.04, Cylinders=2

The power output of the green steam engine is primarily related to the steam temperature and pressure, piston stroke, area of the piston and the number of cylinders inside the engine. The following Table shows the power output of the steam engine in KWH vs. RPM, Shows the power output of the engine with different types of generators and shows the steam consumption with different RPM. This table was calculated at steam pressure 100 Psi, Stroke of 1.5 in, area of 3.04 and the type of the engine is 2 cylinders engine.

Table 4.1: 2 Cylinder Power output

Kwh/RPM			AMPS				Steam Consumption
RPM	HP	Kwh	12V	120V	240V	392V	/minute
100	0.23	0.2	13	1	1	0	0.52
200	0.45	0.3	25	3	1	1	1.04
300	0.68	0.5	38	4	2	1	1.56
400	0.91	0.6	50	5	3	2	2.08
500	1.13	0.8	63	6	3	2	2.60
600	1.36	0.9	76	8	4	2	3.12
700	1.59	1.1	88	9	4	3	3.64
800	1.81	1.2	101	10	5	3	4.16
900	2.04	1.4	113	11	6	3	4.68
1000	2.27	1.5	126	13	6	4	5.19
1100	2.49	1.7	139	14	7	4	5.71
1200	2.72	1.8	151	15	8	5	6.23
1300	2.95	2.0	164	16	8	5	6.75
1400	3.17	2.1	176	18	9	5	7.27
1500	3.40	2.3	189	19	9	6	7.79

Table 4.2: 4 Cylinder Power output

Kwh/RPM			AMPS				Steam Consumption
RPM	HP	Kwh	12V	120V	240V	392V	/minute
100	0.45	0.3	25	3	1	1	1.04
200	0.91	0.6	50	5	3	2	2.08
300	1.36	0.9	76	8	4	2	3.12
400	1.81	1.2	101	10	5	3	4.16
500	2.27	1.5	126	13	6	4	5.19
600	2.72	1.8	151	15	8	5	6.23
700	3.17	2.1	176	18	9	5	7.27
800	3.63	2.4	201	20	10	6	8.31
900	4.08	2.7	227	23	11	7	9.35
1000	4.53	3.0	252	25	13	8	10.39
1100	4.99	3.3	277	28	14	8	11.43
1200	5.44	3.6	302	30	15	9	12.47
1300	5.89	3.9	327	33	16	10	13.51
1400	6.35	4.2	353	35	18	11	14.55
1500	6.80	4.5	378	38	19	12	15.58

As we shown in table 4.1and table 4.2 the higher the RPM, the higher power output we generate from the 2 cylinder green steam engine and the more power we generate the faster the steam is consumed.

Figure 4.9: Household cogeneration unit with steam piston engine

This is a conventional steam engine outer dimension of the unit: 83x62x126 cm; weight 195 kg; electric power output 0,3 to 2 kW; heat power output 3 to 19 kW; efficiency of production electric and heat power is 89 % (in relation to the heating value of an fuel). The unit contains a uni-flow steam engine with a linear electric generator. The manufacturer: OTAG Vertriebs GmbH & Co.KG.

While comparing this current design in the market with the green steam engine it can show that the max output of the current conventional steam engines produce only 2 kW while the green steam engine can reach up to 4.5 kW at 200 psi

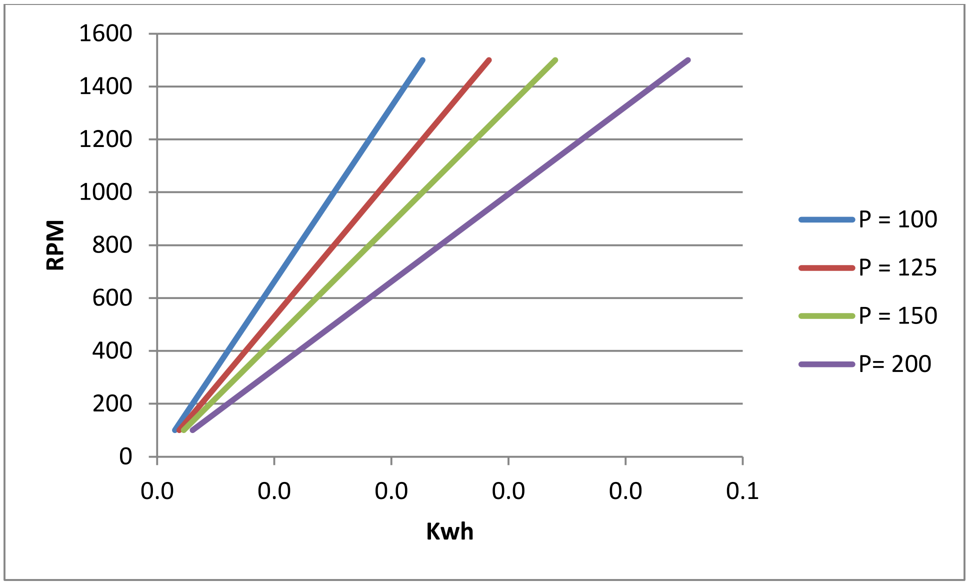


Figure 4.10: RPM vs. Kwh graph

This graph shows the rpm vs. kwh during operating at different pressures 100, 125, 150 and 200 and actually it shows that the higher pressure the higher power we are going to get as we can see at p=100 at 1500 rpm the electric power output is 2.3 Kwh and at p=200 at 1500 rpm the electric power output is 4.5 kwh.

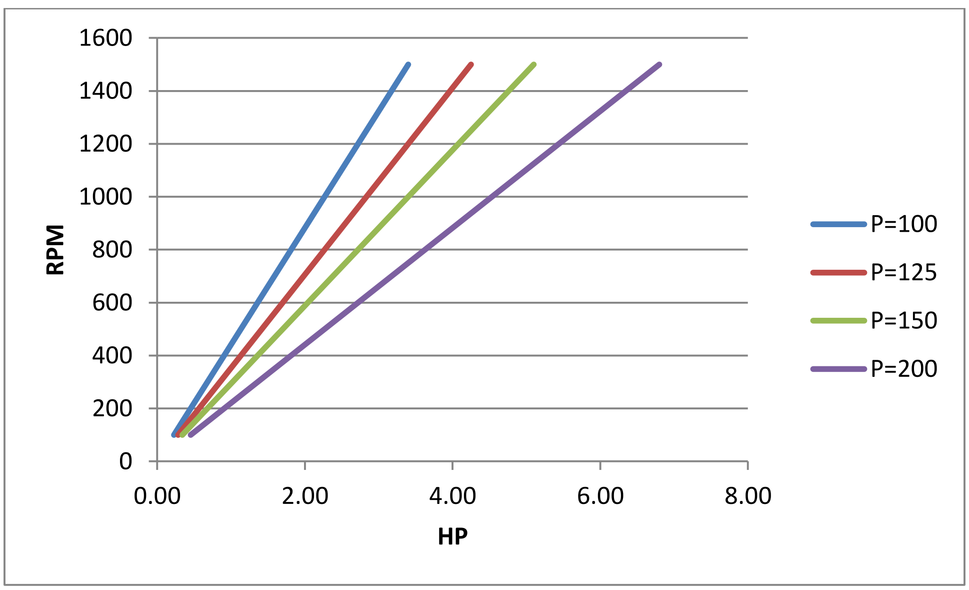


Figure 4.11: RPM vs. HP graph

This graph shows the rpm vs. HP during operating at different pressures 100, 125, 150 and 200 and actually it shows that the higher pressure the higher power we are going to get as we can see at p=100 at 1500 rpm the green steam engine has 3.4 horse power and at p=200 at 1500 rpm it has 6.8 horse power.

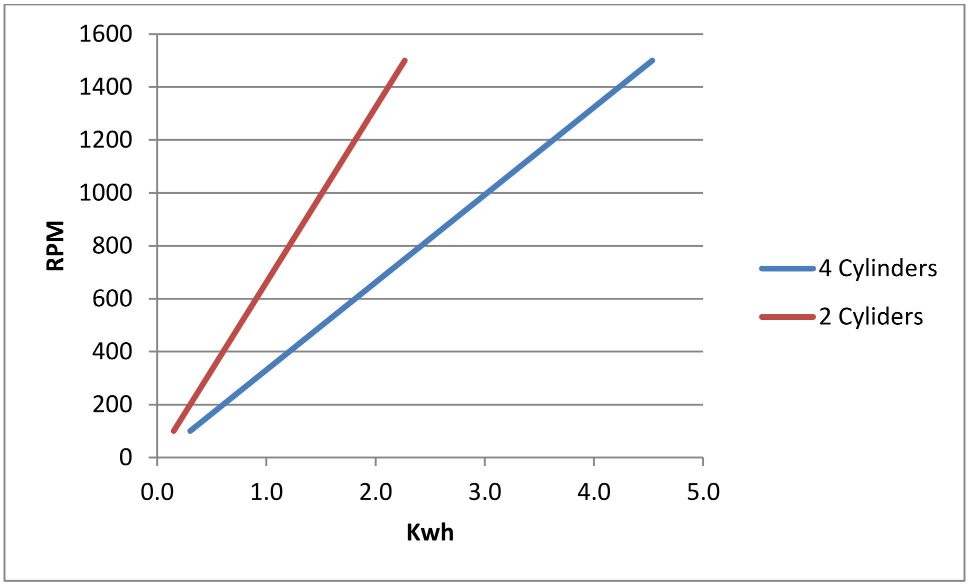


Figure 4.12: RPM and Kwh graph 4 cylinders vs. 2 cylinders

Graph 4.12 shows the difference between the power output of the green steam engine with different number of cylinders as shown the 4 cylinders version of the engine generate more power output but as shown in graph 8 the 4 cylinders engine consume more steam per minute than the 2 cylinders version

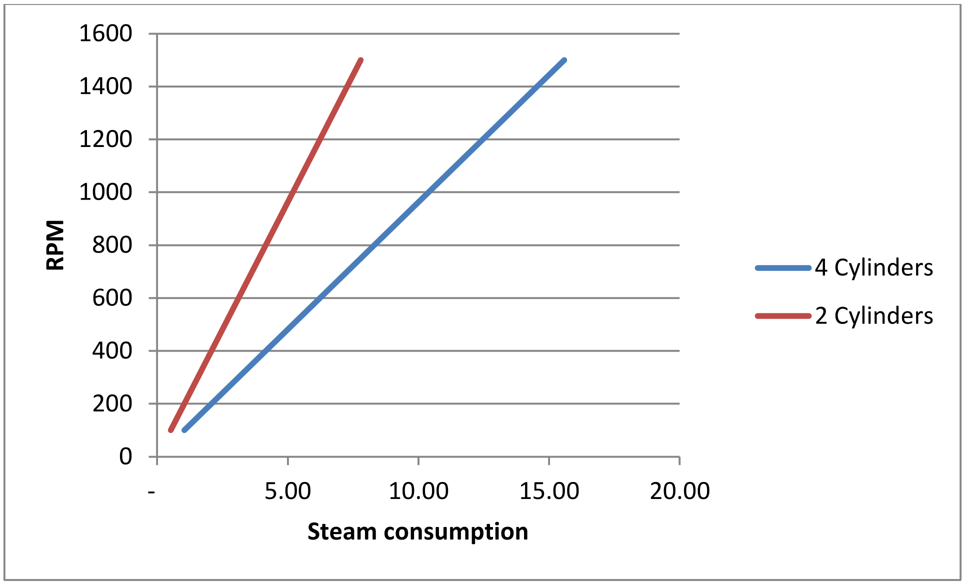


Figure 4.13: RPM and Steam consumption graph 4 cylinders vs. 2 cylinders

At 1500 RPM 2 cylinders engine can generate 2.3 kwh, 3.2 HP and consume steam at 7.70 Cu. Ft. /minute , the 4 cylinders engine can generate 4.5 kwh, 6.8 HP and consume steam at 15.58 Cu. Ft./minute

4.4 Durability

The spherical joint mechanism itself has little, if any, friction. Its purpose is to maintain alignment of the cylinders and prevent rotation of the mechanism and convert reciprocal movement into rotating movement. The deflection of the rod is carried by the head joint and does not cause friction in the rotation of the output shaft. There is never a need for overhaul, oil change or tune-up. Any part on the engine can be replaced in less than five minutes. The engine is designed for continuous operation.

The arrangement, whereby the cylinders are in the same plane as the main shaft permits large engines to occupy a very small and compact space. Engines can fit in a tube.

The same movements that operate the pistons operate the valves in a separate intermittent timing. There is no additional valve actuation mechanism required. The valve opens and closes while the pistons are stopped at top and bottom dead center whereby the valves are fully open throughout the full piston stroke.

The engines may be produced in sizes ranging from fractional horse power to hundreds of horse power and may be operated on air, steam or volatile fluids including refrigerant and expandable gas. Where heat is used to expand and compress the gas, a Rankin cycle is typically employed to recover and recycle heat and fluid. The efficiency is therefore maximized.

4.5 Applications

The Green Steam Engine may be scaled to a range of sizes from micro engines to large industrial engines.

Micro engines can operate tiny mechanisms as well as disposable motors used for medical procedures such as bone grinding and drilling. The engine can operate on inert compressed gas for safe and quiet operating room environments. They may also be used to run model aircraft, small drones, robots, model boats, trains, and toys.

Small engines that produce fractional HP can operate drills, flexible shaft type grinders, small-scale water distillers, cell phone, radio and flashlight chargers, RV and camping water heaters and pumps and electrical generators. This size unit can operate a combined water distiller, battery charger, space heater, and water heater for disaster relief.

Medium engines are ideal for household power generation, automobile charging, air movers and conditioners, heat pumps, water pumps, water distillers, sewage processing, irrigation pumps, greenhouse pumps and boat engines. This size engine may be used in place of, or back-up for solar and wind systems as off grid generators.

Larger engines may be used for utility size electrical generators for villages and multi-unit dwellings and water treatment systems. In addition, it can be used to utilize waste heat from industrial processes, large ship and industrial diesel engines. They may be used to increase the efficiency of fossil fuel engines by utilizing the exhaust heat to operate accessories such as generators, water pumps, etc.

4.5 Competition:

Competition is conspicuously absent for the niche that this steam engine fills. Wind, solar, and gas generators have serious deficiencies that have not been addressed. Wind and solar systems are expensive, require large expenditures for installation and often require permits from governmental agencies. They also increase insurance rates, property tax rates and require frequent cleaning, snow removal and inhibit roof repair. Windmills are restricted to rural areas and often are opposed for noise and aesthetic reasons. They frequently kill birds and throw ice. Windmill repair is problematic as well. The pay-back time is lengthy and the longevity is short.

Gas and diesel generators require expensive fuel, and are noisy. They require frequent maintenance that needs skilled mechanics to repair and they often are hard to start when needed most. The proposed steam engine requires little maintenance, no oil changes, or tune-ups, minor and occasional lubrication and can run 24 hours per day. Maintenance and repair can be done by relatively unskilled local labor with unsophisticated tools. No transmissions are required because steam engines have full power at starting speed. Steam engines are self- starting.

Chapter 5

Conclusion and Recommendation

5.1 Conclusion

Due to understanding the Steam turbines process and the amount of wasted steam during the process. The influence of this understanding led to the idea of reusing the wasted steam to run a low pressure steam engine. The steam engine will increase the efficiency of the steam turbine to produce more electricity, the objectives of this project has been achieved throughout the w

Recent awareness of the pending energy crisis has been illuminated by rapidly rising prices in the energy sector. People in all parts of the world, including developed nations are looking for ways to cut energy costs and find alternative ways of supplying their energy needs. A portable, inexpensive power supply that can operate on fuel as diverse as cattle dung and solar collectors is a niche market with increasingly high potential.

Further, disasters such as hurricanes, floods, earthquakes and storms have shown how vulnerable the electrical grid, water supply and rescue systems can be. Even though there is often ample supply of combustible material available, there is no means to convert the heat into a usable resource. In cold climates, pumping hot water through a small radiator may provide space heating from an outside campfire.

Emergency equipment such as cell phones, radios and battery-powered lights soon give out and there is no way to recharge the batteries. Potable water is soon exhausted as well. An electrical generating system that can operate from any heat source and produce potable water and pumped hot water as a byproduct has an intrinsic value in its own league.

An engine that can run on trash will not want for customers. Many industries produce waste heat and, or waste combustibles that could reduce their energy costs substantially. If they were able to convert the waste to rotary motion, they could easily be convinced of the benefit. Large units may be developed for this market. As the cost of energy increases, the generation of customers will increase exponentially.

Farms could benefit from an engine that could aerate ponds and manure storage tanks as well as run air movers for barn ventilation. These engines can operate on animal waste.

The recreational market is another important customer. Small units that are nearly silent running can operate boats, without the pollution and noise associated with traditional engines. The recreational vehicle and camping industry could well be a major market- providing battery charging, potable water, hot water for washing and space heating for tents and vehicles. Pumped hot water through a small radiator in the tent or camper can provide heat without the danger of fumes. In addition, it should not be ignored that there is a great romantic affection for steam engines historically. A survey of key words “steam engine” on Internet search engines will convince any skeptic as well as point to some of the additional markets not covered here.

5.2 Recommendation

- Find the best conditions to run the steam engine for higher performance.
- Study and understand more about the steam engines and turbines.
- Find out the increase in efficiency of the turbine that can be achieved.

Future development could add home power generators that attach to existing home heating units. A small heat exchanger attached to the heating unit could produce the steam to drive a generator without any additional energy spent. Because the engine units are nearly silent running, they could be placed on or next to the heater. These engines could run heat pumps that could provide air conditioning as well. Microprocessors could easily control all aspects of this system. All the heat that is used for the generator is returned to the space heating. The market for such a system is huge.

The properties provided by this new technology, a steam engine may be constructed that is extremely lightweight, efficient, and economical. They produce virtually no noise and may be operated inside dwellings. Modern methods and materials are used to reinvent the steam engine and bring it into the twenty-first century. Because any combustible fuel as well as solar and geo-thermal heat may be used to operate this engine, it can provide a flexible means of producing power. The engine can operate on very low steam pressure and volume, which reduces boiler requirements for safe domestic operation.

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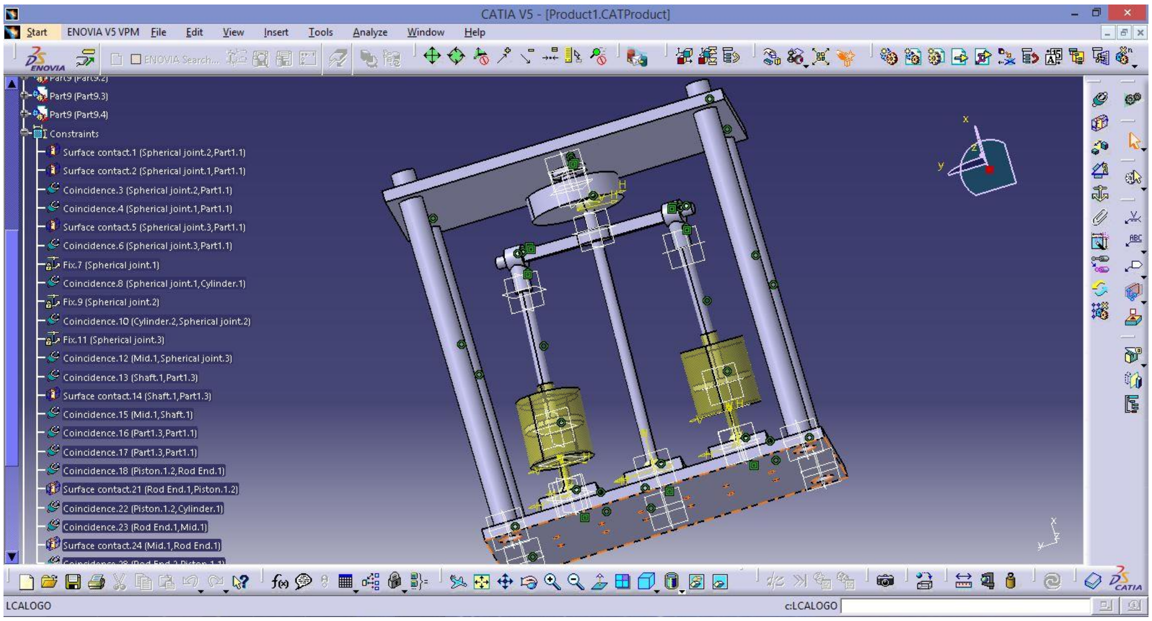
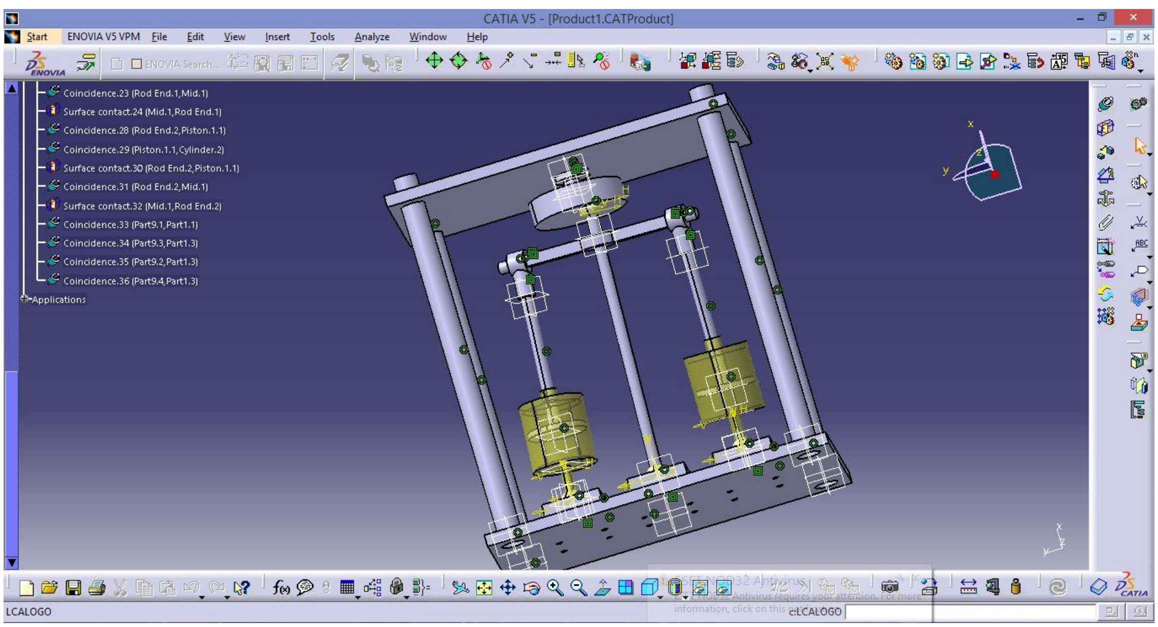
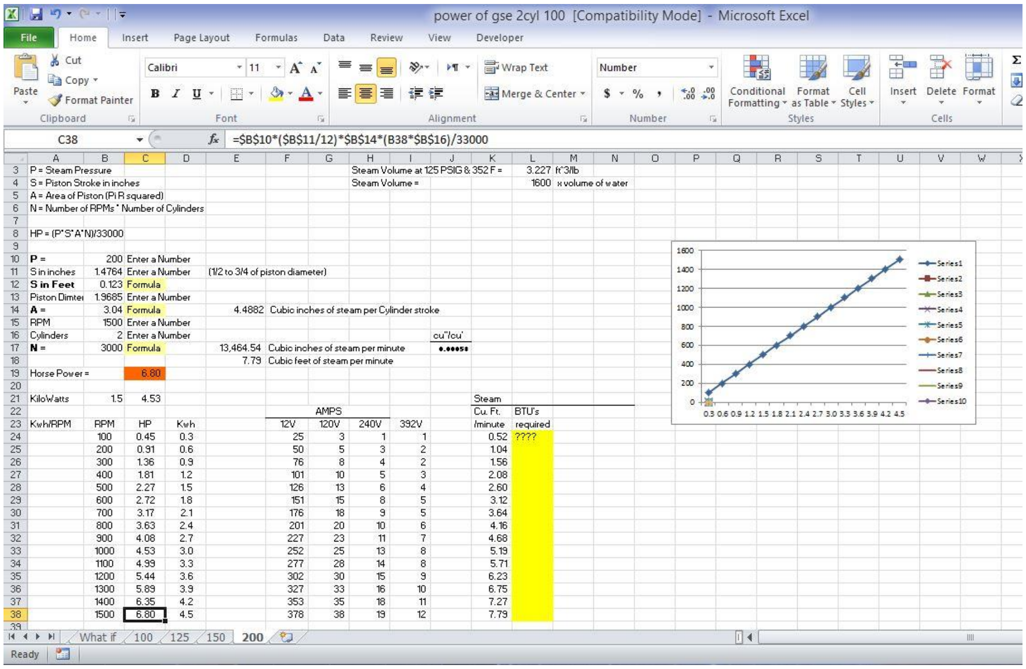
Appendix





The constraints used in the simulation of the 2 cylinder engine



	A	B	C	D	E	F	G	H	I	J	K	L	M
3	P = Steam Pressure							Steam Volume at 125 PSIG & 352 F =				3.227	ft^3/lb
4	S = Piston Stroke in inches							Steam Volume =				1600	x volume of water
5	A = Area of Piston (Pi R squared)												
6	N = Number of RPMs * Number of Cylinders												
7													
8	HP = (P*S*A*N)/33000												
9													
10	**P =**	200	Enter a Number										
11	S in inches	1.4764	Enter a Number		(1/2 to 3/4 of piston diameter)								
12	**S in Feet**	0.123	Formula										
13	Piston Dimter	1.9685	Enter a Number										
14	**A =**	3.04	Formula		4.4882	Cubic inches of steam per Cylinder stroke							
15	RPM	1500	Enter a Number										
16	Cylinders	2	Enter a Number							cu"/cu'			
17	**N =**	3000	Formula		13,464.54	Cubic inches of steam per minute				[illegible]			
18					7.79	Cubic feet of steam per minute							
19	Horse Power =		6.80										
20													
21	KiloWatts	1.5	4.53								Steam		
22							AMPS				Cu. Ft.	BTU's	
23	Kwh/RPM	RPM	HP	Kwh		12V	120V	240V	392V		/minute	required	
24		100	0.45	0.3		25	3	1	1		0.52	????	
25		200	0.91	0.6		50	5	3	2		1.04		
26		300	1.36	0.9		76	8	4	2		1.56		
27		400	1.81	1.2		101	10	5	3		2.08		
28		500	2.27	1.5		126	13	6	4		2.60		
29		600	2.72	1.8		151	15	8	5		3.12		
30		700	3.17	2.1		176	18	9	5		3.64		
31		800	3.63	2.4		201	20	10	6		4.16		
32		900	4.08	2.7		227	23	11	7		4.68		
33		1000	4.53	3.0		252	25	13	8		5.19		
34		1100	4.99	3.3		277	28	14	8		5.71		
35		1200	5.44	3.6		302	30	15	9		6.23		
36		1300	5.89	3.9		327	33	16	10		6.75		
37		1400	6.35	4.2		353	35	18	11		7.27		
38		1500	6.80	4.5		378	38	19	12		7.79		

This excel sheet has all the equations where you can update the engine parameters with any other parameters and then results come out as in horse power and kilowatt based on the RPM value