

VC-T Engine An Advancement in 4-Stroke Engine

Rishikesh Mishra, Prashant Thakare, Shreyas Patil, Kartik Kannav, Nikunj Vitalkar

Abstract: *The most important challenge which the car manufacturers are facing today is to offer vehicles that deliver excellent fuel efficiency and superb performance while maintaining cleaner emissions and driving comfort. This paper deals with the VC-T (Variable Compression Turbo) engine technology which is going to be one of the advanced technology in the IC engine, and also deals with its working principle and its advantages. VC-T is the brand new technology in four cylinder petrol engine family. The VC-T engine is able to maximize its efficiency by running a higher compression ratio at idle or low speeds and boost performance by switching over to lower compression ratio under hard acceleration or heavy engine loads. The VC-T is able to adjust its compression ratio anywhere between its lower limit of 8 :1 to higher limit of 14 :1. According to Infiniti, the engine intrinsic smoothness allows it to achieve the NVH (Noise vibration & harshness) level similar to that of V6 engine. The paper rounds off with conclusions and an agenda for future research in this area.*

Keywords: VC-T Engine, Compression ratio, Nissan Infiniti, Efficiency.

I. INTRODUCTION

Variable compression ratio is a technology to adjust the compression ratio of an internal combustion engine while the engine is in operation. This is done to increase fuel efficiency while under varying loads. Higher loads require lower ratios to be more efficient and vice versa. Variable compression engines allow for the volume above the piston at 'Top dead centre' to be changed. For automotive use this needs to be done dynamically in response to the load and driving demands. Gasoline engines have a limit on the maximum pressure during the compression stroke, after which the fuel/air mixture detonates rather than burns. To achieve higher power outputs at the same speed, more fuel must be burned and therefore more air is needed. To achieve this, turbochargers or superchargers are used to increase the inlet pressure. This would result in detonation of the fuel/air mixture unless the compression ratio was decreased, i.e. the volume above the piston made greater. This can be done to a greater or lesser extent with massive increases in power being possible.

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The down side of this is that under light loading, the engine can lack power and torque. The solution is to be able to vary the inlet pressure and adjust the compression ratio to suit. This gives the best of both worlds, a small efficient engine that behaves exactly like a modern family car engine but turns into a highly tuned one on demand. Variable compression engines have existed for decades but only in laboratories for the purposes of studying combustion processes. These designs usually have a second adjustable piston set in the head opposing the working piston (Very much like model aircraft 'Diesel' engines). Earlier variable compression engines have been highly desirable but technically unobtainable for production vehicles due to the mechanical complexity and difficulty of controlling all of the parameters. However, new solutions like Wallis approach does not use a second piston and is implemented to existing 4-cylinder engine with minor modifications. This is a promising sign towards full commercial production readiness and cost-efficient innovative solution which will change the future of VCR engines.

II. A BRIEF INTRODUCTION TO VC-T

VC-T is the first Variable compression turbo engine introduced by Infinity Motor Company. As the name indicates VARIABLE COMPRESSION, the engine can perform anywhere between the ratio of 8:1 and 14:1. Generally, High compression ratio is used for good stability and low load operation. Low compression ratio used at full load to boost the turbocharger intake pressure. Load increases-Engine exhaust increases-boost available more. At full load turbocharger boost capacity is so high so reduction in Compression Ratio is necessary for more efficiency and reducing thermal stresses. According to infinity, the VC-T engine was a result of more than 20 years' worth of development with more than 300 technologies patented for use in engine. This brand new technology which is going to be launch in 2018 uses the same concept as stated above. Infiniti's VC-T engine technology seamlessly raises or lowers the height the pistons reach. As a consequence, the displacement of the engine changes and the compression ratio can vary anywhere between 8:1 (for high performance) and 14:1 (for high efficiency). The engine control logic automatically applies the optimum ratio, depending on what the driving situation demands. A series of earlier SAE papers published by Nissan engineers laid out the core approach of a new piston-crank system incorporating a multiple-link mechanism to vary the piston's motion at top dead center and thereby obtain the optimum compression ratio matching the operating conditions. This multiple-link variable compression ratio (VCR) mechanism can be installed without increasing the engine size or weight substantially by selecting a suitable type of link mechanism and optimizing the detailed specifications.

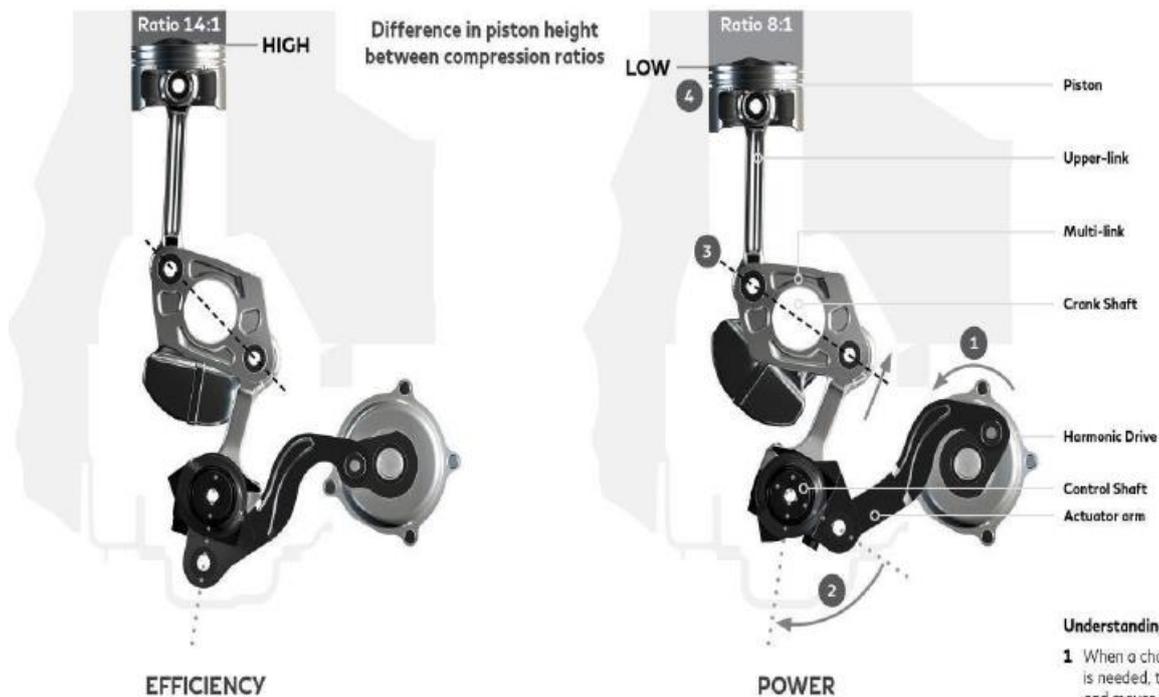
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VC-T technology is a step change for Infiniti. It is a revolutionary next-step in optimizing the efficiency of the internal combustion engine. This technological

breakthrough delivers the power of a high-performance 2.0-liter turbo gasoline engine with a high level of efficiency at the same time.



III. WORKING PRINCIPLE OF VC-T



Understanding VC-T technology

- 1 When a change in compression ratio is needed, the Harmonic Drive turns and moves the actuator arm
- 2 The actuator arm rotates the control shaft
- 3 As the control shaft rotates, it acts upon the lower-link, which changes the angle of the multi-link
- 4 The multi-link adjusts the height the piston can reach within the cylinder, thus changing the compression ratio



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A. Advantages of VC-T

- It will show high efficiency at lower engine power levels.
- It will be able to deliver the power of a high performance 2-litre petrol engine and even match certain 6 cylinder petrol engines, with the torque and efficiency of a modern turbo diesel without the bothersome emissions.
- New infiniti VC-T also limits the lateral movement of each piston to promote smooth running
- It will have a favorable burn rate and coefficient of variance, which allow the application of lean burn technology.
- VC-T engine is very much compact with a higher power to weight ratio.
- It's principle causes low thermal and structural loads.
- It will have a very low frequency noise.

IV. RELATED WORK

Historically two stroke engine petrol engines find wide applications in construction of two wheelers worldwide, however due to stringent environmental laws enforced universally, these engines are fading in numbers. In spite of the tight norms, internationally these engines are still used in agriculture, gensets etc. Several designs of variable compression ratio two stroke engines are commercially available for analysis purpose. In this present investigation a novel method of changing the compression ratio is proposed, applied, studied and analyzed. The clearance volume of the engine is altered by introducing a metal plug into the combustion chamber. This modification permitted to have four different values of clearance value keeping in view of the studies required the work is brought out as two sections. The first part deals with the design, modification, engine fabrication and testing at different compression ratios for the study of performance of the engine. The second part deals with the combustion in engine using FLUENT and analysis of exhaust gases. Increase in compression ratio improves fuel efficiency and power output. The novelty in this work is to permit the two wheeler driver to change the compression ratio.

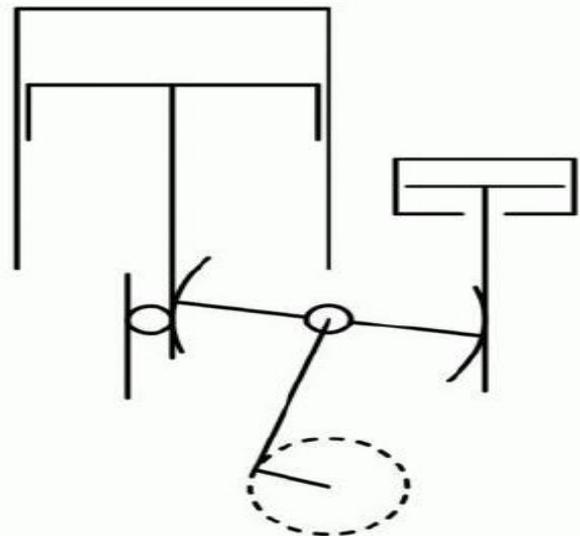
a) Waulis Motors Ltd

Waulis Motors Ltd is founded in 2011 by experienced engine technology experts in Espoo, Finland. The patented technology itself is based on the decade's research and planning made by Aulis Pohjalainen. As an outcome of that process the first working prototype saw the daylight in summer 2011. Company's invention aims to remove the pressure related disadvantages of the existing conventional motors and provide a motor which has substantially lower loss of thermal energy, increased output per litre, and which

decreases CO2 emissions about 30-40 % compared to conventional motors. Waulis develops a new innovative patented technology solution that resolves the existing changes in cylinder pressure adjustment in a cost-effective way. Compared to Waulis, existing VCR technology solutions are much more complex to produce, challenging to control, and substantially much more expensive to implement. In other words, Waulis develops a solution, which manufacturing costs in contrast to achieved benefits are remarkable competitive compared to its rivals.

Waulis design describes a crank device and an adjusting device of a combustion engine. The system adjusts the cylinder pressure of the motor in accordance with the required power. Adjustment of the cylinder pressure takes place by changing the compression ration by means of the adjusting device. The adjusting device changes an eccentric wheel through an adjusting wheel to a such position that a connecting rod lifts a piston to a desired distance from the combustion chamber head. The adjusting device measures the volume of the air entering the cylinder and adjusts the compression ratio to be appropriate. The adjusting device also takes into account the speed of rotation so that the compression pressure increases or decreases to be appropriate.

b) Peugeot MCE-5



Principle of the MCE-5 ("Multi Cycle Engine - 5 parameters"), the variable compression ratio engine made by Peugeot.

The Peugeot design works by varying the effective length of the con-rods connecting the piston to the crank. When the con-rod is shorter, the compression ratio is lower and vice versa. On the left hand-side of the diagram is the conventional piston of an internal combustion engine. On the right is an hydraulic cylinder with double-acting piston. This acts through a rod-crank system with a gear wheel, whose movement adjusts the effective con-rod length and thus the compression ratio in the left cylinder.



V. CONCLUSION

The significant conclusions from the present work are summarized as follows:

- The compression ratio is varied by using a simple mechanism.
- The total fuel consumption increased with the compression ratio.
- The specific fuel consumption reduced with compression ratio.
- The mechanical efficiency increased with compression ratio .
- It automatically adjusts the Compression ratio according to the conditions.

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