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DESIGN AND EXPERIMENTAL INVESTIGATION OF MODIFIED FOUR STROKE TO SIX STROKE CAM PROFILE

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ABSTRACT

The increasing demands for low emissions and low fuel consumption in modern combustion engines require improved methods for combustion process. In order to attain those conditions; a four stroke cam is modified into a six stroke cam by using various calculations. The camshafts and its associated parts control the opening and closing of the two valves. The associated parts are push rods, rocker arms, valve springs and tappets. This shaft also provides the drive to the ignition system. The camshaft is driven by the crankshaft through timing gears. Cams are made as integral parts of the camshaft and are designed in such a way to open the valves at the correct timing and to keep them open for the necessary duration. In this project, a six stroke camshaft is designed for a two wheeler engine by using theoretical calculations. Cam profile is designed by using the calculations. A 2D model of the Camshaft is created using modeling software AutoCAD. For manufacturing cam shaft following manufacturing method are used by Machining, Casting and Forging. From above processes we selected casting processes because it's used for bulk production. For the manufacture of Camshaft Core and Cavity is to be extracted from the model using manufacturing module in AutoCAD. Total Mould base is to be designed for the camshaft which is ready to go for production. CNC Program is to be generated for both core and cavity using roughing and finishing processes. This is also done in manufacturing module in AutoCAD. AutoCAD is the standard in 2D product design, featuring industry-leading productivity tools that promote best practices in design.

KEYWORDS: CAD/CAM/CAE, Auto CAD

INTRODUCTION

- The ageing population is one of the most critical global issues. A survey from the United Nations shows that the number of population over 60 years will increase from 810 million to 2 billion between 2012 and 2050 [1,2].
- Stroke is one of the leading causes of the permanent disability throughout the world, and nearly three quarters of all strokes occur in people over 65 years [2, 3].
- A camshaft is a shaft to which a cam is fastened in which a cam forms an integral part. In internal combustion engines through pistons, the camshaft is used to run poppet valves. [4].
- In order to help people who have difficulty in walking, many researchers have been carried out. It has been proven that repetitive and intensive gait training is helpful to regain the walking ability [5].
- However, the conventional rehabilitation exercises are labor intensive and expensive for most patients [6, 7], which limits their pervasive application.

- The high-pressure fuel system greatly influences fuel injection, fuel spray, combustion, and diesel engine output power and emissions under both steady-state and transient conditions [8,9].
- The electronically controlled high-pressure fuel systems, such as the CRDI (common rail direction injection) fuel system, the EUI (electronic unit injector) fuel system, the EUP (electronic unit pump) fuel system, the PPN (pump-pipe-nozzle) system and the inline fuel system, are widely applied in heavy-duty engines, due to its good features such as the very high injection pressure, precise control of fuel quantity and great system efficiency. In modern diesel engines, CRDI, is highly flexible in electronically control strategies in terms of high fuel injection pressures, exact injection timing and multi injections; the fuel pressure in this fuel system has little direct relationship with the engine speed since the fuel is reserved in the rail and always kept at a high level. These advantages of CRDI benefit it to provide the engine high enough injection pressure even at low engine speed and high engine load and speeds, which is good to meet the varied demands at different engine conditions and suitable for vehicles and power units [8,10,11].

CAM NOMENCLATURES

Cam profile is the actual working surface contour of the cam. It is the surface in contact with the knife-edge, roller surface, or flat-faced follower.

Base circle is the smallest circle drawn to the cam profile from the radial cam center. Clearly, the cam size is dependent on the recognized size of the base circle.

Trace point is the point on the follower located at the knife-edge, roller center, or spherical-faced center.

Pitch curve, or pitch profile, is the path of the trace point. In cam layout, this curve is repeatedly determined first and the cam profile is frequently determined first and the cam profile is then conventional by tangents to the roller or flat-faced follower surfaces. For the basic knife-edge follower, the pitch curve and cam profile are the same.

Prime circle is the smallest circle drawn to the pitch curve from the cam center. It is parallel to the base circle.

Pressure angle is the angle (at any point) between the normal to the pitch curve and the direction of the follower motion. This direction of the follower motion. This angle is significant in cam design because it represents the steepness of the cam profile, which if too large can affect the smoothness of the action.

Pitch point is that point on the pitch curve having the largest pressure angle. Pitch circle is well-defined as the circle drawn through the pitch point with its center at the cam center.

CAM SPECIFICATIONS

Cam diameter = 24 mm

Cam width = 0.7mm

Cam height = 30 mm

Total lift of cam = 6 mm

Base circle radius = 12 mm

Inlet Cam outstroke angle = 25.5°

Inlet Cam dwell angle = 30°

Inlet Cam return stroke angle = 25.5°

Exhaust Cam outstroke angle = 24°

Exhaust Cam dwell angle = 30°

Exhaust Cam return stroke angle = 24°

Inlet valve open = 12° Before TDC

Inlet valve close = 42° After BDC

Exhaust valve open = 42° Before BDC

Exhaust valve close = 12° After TDC

CAM CALCULATIONS

For a Four stroke:

Cam revolution ratio=1:2

- Angle of inlet cam valve operating period = valve opened time in crank angle×cam revolution ratio

  =234°×1/2

  =234×1:2

  =117°

- Angle of inlet cam dwell period = total angle-inlet cam angle

  =360-117

  =243°

- Angle of exhaust cam valve operating period =valve opened time in crank angle×cam revolution ratio

  =234×1:2

  =117°

- Angle of exhaust cam dwell period = total angle-exhaust cam angle

  =360-117

  =243°

For a Six stroke:

Cam revolution ratio=1:3

- angle of inlet cam valve operating period= valve opened time in crank angle×cam revolution ratio

=243×1:3

=81 °

- Angle of inlet cam dwell period = total angle-inlet cam angle

=360-81

=279°

- Angle of exhaust cam valve operating period=valve opened time in crank angle×cam revolution ratio

=234×1:3

=78 °

- angle of exhaust cam dwell period

Dwell time=126×1:32

=42°

- Exhaust valve opened time in crank angle=valve opened time in crank angle×cam revolution ratio

=234×1:3

=78°

CAM DESIGN IN AUTO CAD

Inlet Cam

Inlet cam is used in order to open and close the inlet valve. Inlet cam design consists of a single nose with base radius of 12mm with a stroke/lift of 6mm. The timing gear which is connected to this inlet cam operates the rocker arm. Now the rocker arm operates the valve openings and valve closings. This inlet cam works after the completion of air outlet stroke**.**

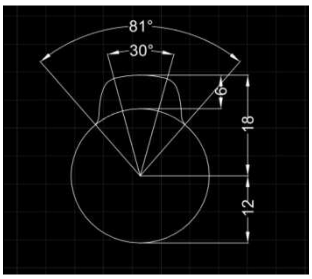

Figure 1

Exhaust Cam

Exhaust cam is used inorder to open and close the exhaust valve. Exhaust cam design consists of two noses with a base radius of 12mm followed with a stroke/liftof 6mm. The timing gear which is connected to this exhaust cam operates the rocker arm. Now the rocker arm operates the valve openings and valve closings. As it contains two noses, the valve openings and closings occur twice.

This exhaust cam works after the completion of power stroke and again after the completion of air inlet stroke.

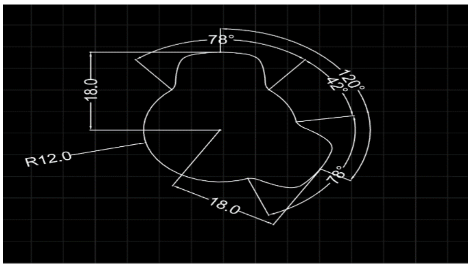

Figure 2

Inlet Cam Displacement Diagram

The inlet cam opens the inlet valve at an angle of 25.5 degree from the initial point at a stroke/lift of 6mm, which is referred to as an outstroke. The cam maintains this stroke of 6mm up to an extent of 30degree which is known as to be dwell period. After the dwell period the cam closes the valve at an angle of 25.5degree followed with a stroke of 6mm which is referred to as a return stroke. Finally this cam maintains the stroke of 6mm up to an extent of 279degree, which is referred to as a dwell period.

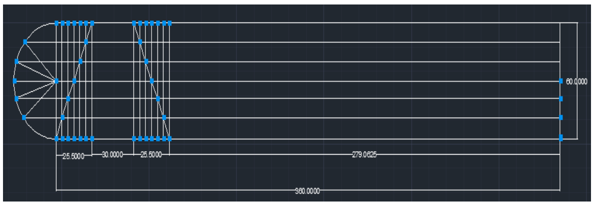

Figure 3

Outlet Cam Displacement Diagram

As it is a six stroke outlet cam with two noses, the outlet and return strokes will occurs twice. Coming to the outlet cam displacement, the exhaust cam opens the inlet valve at an angle of 24degree from the initial point at a stroke/lift of 6mm, which is referred to as an outstroke. The cam maintains this stroke of 6mm upto an extent of 30degree which is known as to be dwell period. After the dwell period, the cam closes the valve at an angle of 24degree followed with a stroke of 6mm which is referred to as a return stroke after the return stroke. After this return stroke, the cam maintains the stroke of 6mm upto an extent of 42degree, which is referred to as a dwell period. Again the cam gets opened at a lift of 6mm in which air suction and air outlet stroke occurs. After the dwell period, the exhaust cam again opens the inlet valve at an angle of 24degree at a stroke/lift of 6mm, which is referred to as an outstroke. The cam maintains this stroke of 6mm upto an extent of 30degree which is known as to be dwell period.. After the dwell period, the cam closes the valve at an angle of 24degree followed with a stroke of 6mm which is referred to as a return stroke. Finally this cam maintains the stroke of 6mm upto an extent of 162degree, which is referred to as a dwell period.

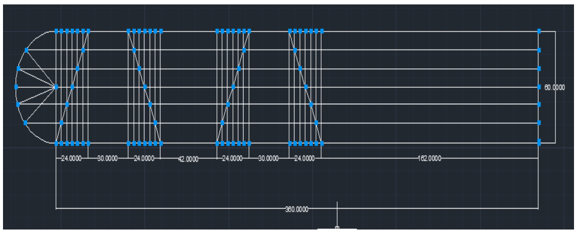

Figure 4

- Rise - is when the follower is poignant away from the cam centre.
- Dwell - is the period when the follower is motionless.
- Return - is when the follower moves back near the cam centre.
- Stroke– is the greatest distance over which the follower moves. Displacement (s) – is the location of the follower from a specific zero or rest point in relation to time or the rotary angle of the cam.
- Velocity– is the rapidity with which the cam moves the follower.
- Acceleration is the rate of change of is the rate of modification of the follower's velocity.
- A follower displacement diagram is a graph showing displacement of the follower plotted as a purpose of time. Since the cam usually rotates at perpetual angular velocity, the t-axis can be measured as the θ-axis.
- The follower displacement diagram regulates the shape of the cam.

VALVE TIMING DIAGRAM

Hypothetically it may be expected that the valves open and close and the spark (or injection of fuel) happens at the engine dead centers. However, in real operation, the valves do not operate at dead center positions but operate certain degree on either side of the dead centers. The opening arises earlier and the exhaust continues uniform at later crank angles. The ignition is also timed to arise in advance of the achievement of compression stroke.

The timing of these events, raised in terms of crank angles from dead center sites, is characterized on a valve timing diagram. The correct timings are of essential importance for the effective and positive running of the I.C. engine.

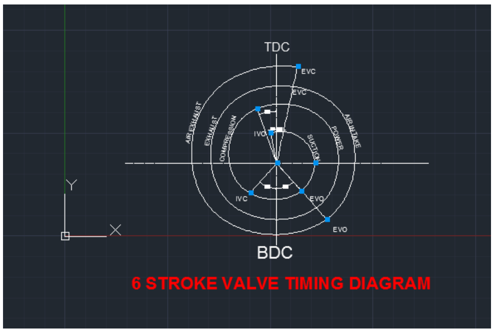

Figure 5

In the case of actual valve timing diagram valve openings, valve closings and auto ignition occurs at a certain degree before or after the dead centers. In this case, the inlet valve opens at 12 degree before the TDC and the suction stroke is followed. The inlet valve will be closed at 42 degree after BDC. After the completion of the suction stroke, the compression stroke will be followed. At this compression stroke, the auto ignition occurs at an angle of 20 degree before the TDC. After the compression stroke, power stroke follows and then the exhaust valve gets opened at an angle of 42degree before the BDC. After the opening of exhaust valve, the exhaust stroke will be followed. After the completion of this exhaust stroke, the exhaust stroke will be closed at an angle of 12degreeafter the TDC. As it was a six stroke cam the exhaust cam has two noses in which the valve openings and valve closings occurs twice at a same angle. After the exhaust stroke completion, air suction stroke occurs and the exhaust will be opened againat an angle of 42degree before the BDC. After the opening of this exhaust valve, air outlet stroke will be followed. Finally, the exhaust valve gets closed at an angle of 12degree after the TDC.

TDC – Top Dead Centre

BDC – Bottom Dead Centre

IVO – Inlet Valve Opens

IVC – Inlet Valve Close

IG – Ignition Starts

EVO – Exhaust Valve opens

EVC – Exhaust Valve Close

Front View

Figure 6

Top View

Figure 7

MODIFIED 6 STROKE CAM

Front View

Figure 8

Top View

Figure 9

TIMING GEAR

The gear train with a two to one reduction through which the crankshaft drives the camshaft and thus controls valve timing in an internal-combustion engine.

Four Stroke Timing Gear

The timing gear of a four stroke engine consists of 32 teeth with a cam revolution ratio of 1:2. Here for every two rotations of a crank, the timing gear rotates a single rotation.

Figure 10: Four Stroke Timing Gear

Six Stroke Timing Gear

The timing gear of a six stroke engine consists of 48 teeth with a cam revolution ratio of 1:3. Here for every three rotations of a crank the timing gear rotates a single rotation.

Figure 11

CONCLUSIONS

In this paper, the camshaft is designed by using theoretical calculations for the 135cc gasoline engine. In further step, we have modeled a camshaft as per the design calculations. Shrinkage allowance is also added in this design. Also, Core and cavity for camshaft have been executed. The total mould base according to standards has prepared. The manufacturing process for the camshaft is generated by means of CNC programming. This modified six stroke cam enables lower engine temperature and therefore increases in the overall efficiency.

REFERENCES

1. D. Tang, B. Yusuf, J. Botzheim, N. Kubota, C.S. Chan, A novel multimodal communication framework using robot partner for aging population, Expert Syst. Appl. 42(2015) 4540–4555.
2. B. Chen, H. Ma, L. Qin, F. Gao, K. Chan, S. Law, L. Qin,W. Liao, Recent developments and challenges of lower extremity exoskeletons, J. Orthop. Translat. 5 (2016) 26–37.
3. Q. He, C. Wu, H. Luo, Z.Y. Wang, X.Q. Ma, Y.F. Zhao, J. Lu, C. Xiang, Y.Y. Qin, S.Q. Wu, F.F. Yu, J. He, Trends in in-hospital mortality among patients with stroke in China, PLoS One 9 (2014), e92763.
4. H.S. Lo, S.Q. Xie, Exoskeleton robots for upper-limb rehabilitation: state of the art and future prospects, Med. Eng. Phys. 34 (2012) 261–268.
5. M. Pohl, C.Werner, M. Holzgraefe, G. Kroczek, I.Wingendorf, G. Hoölig, R. Koch, S. A single-blind, randomized multicentre trial (DEutsche GAngtrainerStudie, DEGAS), Clin. Rehabil. 21 (2007) 17–27.
6. Z. Ji, Y. Manna, Synthesis of a pattern generation mechanism for gait rehabilitation, J. Med. Devices 2 (2008) 031004.
7. W. Wang, Z. Hou, L. Tong, F. Zhang, Y. Chen, M. Tan, A novel leg orthosis for lower limb rehabilitation robots of the sitting/lying type, Mech. Mach. Theory 74 (2014) 337–353.

8. Magno A, Mancaruso E, Vaglieco BM. Experimental investigation in an optically accessible diesel engine of a fouled piezoelectric injector. Energy 2014; 64:842e52.

9. Rakopoulos CD, Dimaratos AM, Giakoumis EG, Rakopoulos DC. Evaluation of the effect of engine, load and turbocharger parameters on transient emissions of diesel engine. Energy Converse Manage 2009; 50(9):2381e93.

10. Agarwal AK, Dhar A, Gupta JG, Kim W, Lee CS, Park S. Effect of fuel injection pressure and injection timing on spray characteristics and particulate size number distribution in a biodiesel fuelled common rail direct injection diesel engine. Appl Energy 2014; 130:212e21.

11. Bae J, Kim C. A study on integrated design for improving fatigue life of common rail pipe considering stress concentration at complex shape. J Mech Sci Technol 2014; 28(9):3617e27.