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STUDY AND EFFECTS OF MAKING GROOVES ON PISTON HEAD AND PERFORMANCE TEST ON SINGLE CYLINDER CI ENGINE

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Abstract-- *The in-cylinder air flow indication in internal combustion engines is one of the most common factors in controlling the combustion process. It controls the fuel-air mixing and ignition rates in diesel engines. In this current work Study and effects of making grooves on piston head and performance test on single cylinder CI engine. This increasing the swirls by cutting grooves on top of the piston head, with three different configurations of 3GP, 6GP and 9 grooves pistons are investigating performance and its effects. Experiments are carried out on a diesel engine using modified different configuration pistons. By keeping hemispherical grooves the fuel and air mixing ratio will be increased and also brake thermal efficiency will beincreased, and mechanical efficiency will decreased.*

Keywords-- *Diesel engine, Air swirls, Grooves, Efficiency, and Squish.*

I. INTRODUCTION

Internal combustion engines have been moderately inexpensive and reliable source of power for applications ranging from small to large scale industrial and transport applications for most of the 20th era. Direct injection (DI) Diesel engines, having the evident benefit of a higher thermal efficiency than all other engines.

The working of four stroke DI diesel engine is having four strokes. They are suction, compression, combustion, and exhaustion stroke. In suction stroke the inlet valve opens and air enters into the combustion chamber piston moves from TDC to BDC. After it reaches to BDC the inlet valve was closed. During compression stroke piston moves from BDC to TDC with high compression ratio. Piston reaches TDC fuel injector will sprays the fuel the air fuel particle are collide each other and combustion take place in combustion chamber. After combustion certain force or power will generated, piston moves from TDC to BDC the power transforming chemical energy to mechanical energy. Exhaustion stroke piston moves from BDC to TDC exhaust valve will open and all burnt gases are sent out and unburnt gases are remains constant. After that exhaust valve will close.Here in this modifying the piston design with grooves having 3 different configurations. They are 3, 6, and 9.The main important of making grooves is when the inlet valve open piston will move fromTDC to BDC. The airenters into the combustion chamber while having the hemisphericalgrooves on piston head the air will swirls to enter combustion chamber. After that both valves are closed, the piston moves from BDC to TDC here squish and swirls will be generated and compared to the normal piston, the temperature of air is high and the turbulence will be created in combustion chamber. When piston touch's the TDC fuel injector will sprays the fuel. The better mixing of fuel and air the particles collide each other and the unburnt particles will be fully burnt. This is reason for making grooves on piston for better mixing of fuel and air in combustion chamber to give better brake thermal efficiency, reducing the specific fuel consumption and reduce the exhaust gas temperature.

II. EXPERIMENTAL SETUP AND PROCEDURE

The experiments were carried out on a single cylinder four stroke water cooled diesel engine. It was provided with accessories for the measurement of load, fuel consumption, spring balance weight, diameter of pulley, rope weight, and load on hanger.

In the present work the effects of air swirls in combustion chamber are experimentally studied on single cylinder water cooled compression ignition engine. To intensify the air swirls number of hemispherical grooves were made on the piston crown. The different types of piston which were tested in diesel engine.

Figure1. Experimental set up

The Three grooves piston has been cutted in the vertical C.N.C Milling Machine (Computer Numerical Control). The diameter of the groove is 8mm and depth of the groove is 4mm. The diameter of the piston was 80mm and its stroke length was 110mm. The angle of the three groove was 120degrees. And the time taken for cutting the grooves was 2mins 55sec.

Figure2. 3Grooves Piston

The Six grooves piston has been cutted in the vertical C.N.C Milling Machine (Computer Numerical Control). The diameter of the groove is 8mm and depth of the groove is 4mm. The diameter of the piston was 80mm and its stroke length was 110mm. The angle of the three groove was 60degrees. And the time taken for cutting the grooves was 4mins 46sec.

Figure3. 6 Grooves Piston

The Nine grooves piston has been cutted in the vertical C.N.C Milling Machine (Computer Numerical Control). The diameter of the groove is 8mm and depth of the groove is 4mm. The diameter of the piston was 80mm and its stroke length was 110mm. The angle of the three groove was 120degrees. And the time taken for cutting the grooves was 7mins 7sec.

Figure4. 9 Grooves Piston

III. SPECEFICATION OF DIESEL ENGINE

Item	Specifications
Ignition system	Compression ignition
Arrangement of cylinder	Vertical
Cooling	Water cooled
Bore	80mm
Stroke	110mm
Compression ratio	16.5:1
Rated power	5HP
Speed	1500 RPM

IV.RESULTS AND DISCUSSIONS

Table1. Performance Parameters for Existing Piston:

LOAD (Kg)	SPEED (RPM)	B.P (Kw)	TIME (SEC)	BSFC (Kg/kWhr)	I.P (Kw)	BMEP (bar)	IMEP (bar)	η_{bth} (%)	η_{ith} (%)	η_{mech} (%)
0	1652	0.48	112	0.86	1.48	0.63	1.9	9.9	30.6	32.4
2	1650	0.21	100	2.8	1.21	0.27	1.5	3.06	17.2	17.7
4	1653	0.51	91	1.27	1.51	0.68	1.9	6.69	19.6	34.1
6	1649	0.82	89	0.82	1.82	1.07	2.3	10.3	22.9	45.0
8	1650	1.12	70	0.77	2.12	1.47	2.7	11.1	21.0	52.8
10	1651	1.42	61	0.69	2.42	1.86	3.1	12.2	20.9	58.6
12	1652	1.73	54	0.64	2.73	2.27	3.5	13.2	20.8	63.3

Table2. Performance Parameters for 3Grooves Piston:

LOAD (Kg)	SPEED (RPM)	B.P (Kw)	TIME (SEC)	BSFC (Kg/kWhr)	I.P (Kw)	BMEP (bar)	IMEP (bar)	η_{bth} (%)	η_{ith} (%)	η_{mech} (%)
0	1665	0.48	128	0.97	1.58	0.63	2.05	8.7	28.6	30.6
2	1660	0.21	112	2.51	1.31	0.28	1.71	3.4	20.7	16.4
4	1664	0.50	105	1.14	1.60	0.65	2.08	7.5	24.0	31.5
6	1667	0.82	95	0.77	1.92	1.06	2.49	11.0	25.8	42.7
8	1663	1.11	81	0.67	2.21	1.45	2.88	12.7	25.3	50.4
10	1666	1.43	67	0.63	2.53	1.86	3.29	13.5	24.0	56.5
12	1664	1.725	59	0.59	2.82	2.24	3.67	14.4	23.6	61.1

Table3. Performance Parameters for 6Grooves Piston:

LOAD (Kg)	SPEED (RPM)	B.P (Kw)	TIME (SEC)	BSFC (Kg/kWhr)	I.P (Kw)	BMEP (bar)	IMEP (bar)	η_{bth} (%)	η_{ith} (%)	η_{mech} (%)
0	1700	0.49	148	0.83	1.69	0.63	2.1	10.2	35.5	29.2
2	1703	0.21	124	2.23	1.41	0.27	1.7	3.8	24.8	15.3
4	1697	0.49	107	1.13	1.69	0.63	2.1	7.4	25.6	29.4
6	1698	0.83	98	0.73	2.03	1.06	2.5	11.5	28.2	41.0
8	1702	1.13	86	0.62	2.33	1.44	2.9	13.7	28.4	48.4
10	1699	1.45	74	0.56	2.65	1.85	3.3	15.2	27.8	54.7
12	1704	1.749	64	0.54	2.94	2.21	3.7	15.7	26.6	59.1

Table4. Performance Parameters for 9Grooves Piston:

LOAD (Kg)	SPEED (RPM)	B.P (Kw)	TIME (SEC)	BSFC (Kg/kWhr)	I.P (Kw)	BMEP (bar)	IMEP (bar)	η_{bth} (%)	η_{ith} (%)	η_{mech} (%)
0	1705	0.49	159	0.76	1.99	0.62	2.53	11.0	44.8	24.6
2	1707	0.21	131	2.15	1.71	0.26	2.17	3.91	31.8	12.2
4	1710	0.48	110	1.13	1.98	0.60	2.51	7.6	31.4	24.2
6	1702	0.83	103	0.70	2.33	1.05	2.97	12.2	34.4	35.6
8	1704	1.13	98	0.54	2.63	1.4	3.34	15.8	36.9	42.9
10	1706	1.45	77	0.54	2.95	1.8	3.75	15.9	32.4	49.1
12	1708	1.747	66	0.52	3.24	2.2	4.11	16.3	30.5	53.7

1. Brake thermal efficiency:

The brake thermal efficiency with brake power will conducted performance test on normal piston and designed grooves piston. The brake thermal efficiency for the normal piston with full load is 13.2%. And compared with another 3GP, 6GP and 9GP with full load 14.4%, 15.7% and 16.3%. As shown in Figure: 5. The brake thermal efficiency has increasing with increasing brake power. Comparison of normal piston and 9grooves pistons brake thermal efficiency will increased up to 3.1%.

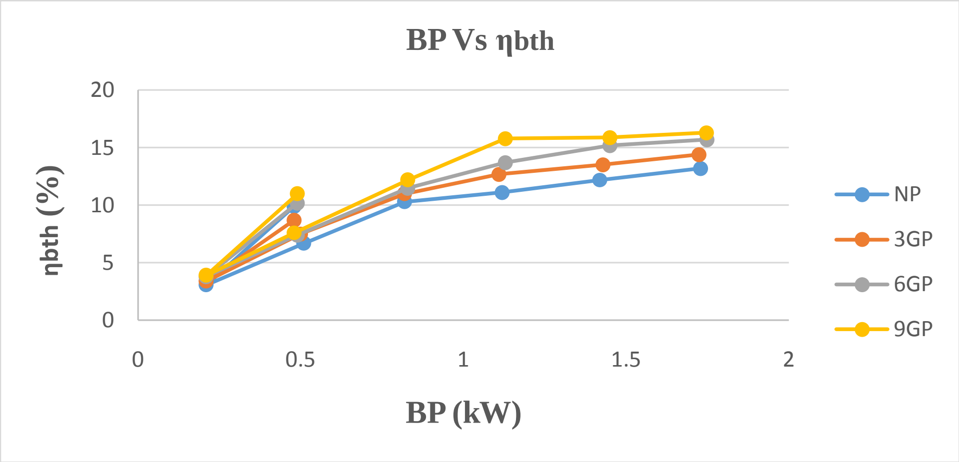

Figure5. Brake power Vs Brake thermal efficiency

2. Brake specific fuel consumption:

The brake specific fuel consumption with brake power will conducted performance test on normal piston and designed grooves piston. The brake specific fuel consumption for normal piston with full load is 0.64kg/hr-kW. And compared with another 3GP, 6GP and 9GP with full load 0.59kg/hr-kW, 0.54kg/hr-kW and 0.52kg/hr-kW. As shown in Figure: 6. The brake specific fuel consumption has slightly decreases with increasing brake power. Comparison of normal piston and 9grooves pistons brake specific fuel consumption will be decreased up to 0.12kg/hr-kW.

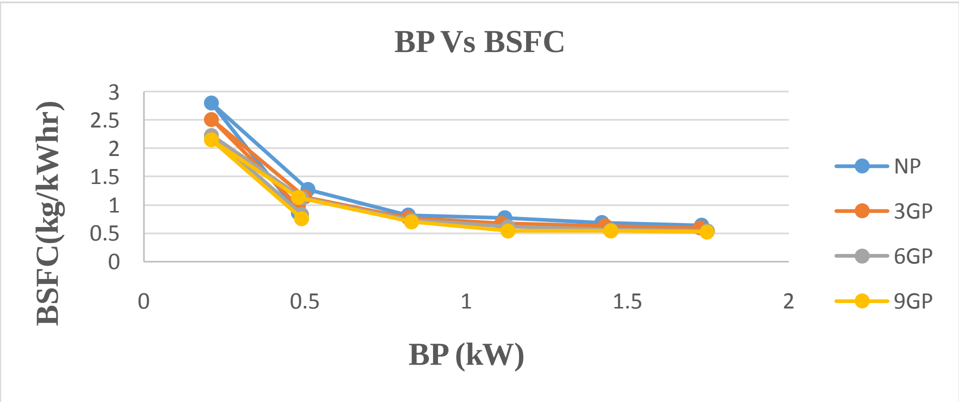

Figure6. Brake power Vs Brake specific fuel consumption

3. Indicated power:

The indicated power with brake power will conducted performance test on normal piston and designed grooves piston. The indicated power for normal piston with full load is 2.73kW. And compared with another 3GP, 6GP and 9GP with full load 2.82kW, 2.94kW and 3.24kW. As shown in Figure7. The indicated power has increased with increasing brake power. Comparison of normal piston and 9grooves piston the indicated power will increased up to 0.51kW.

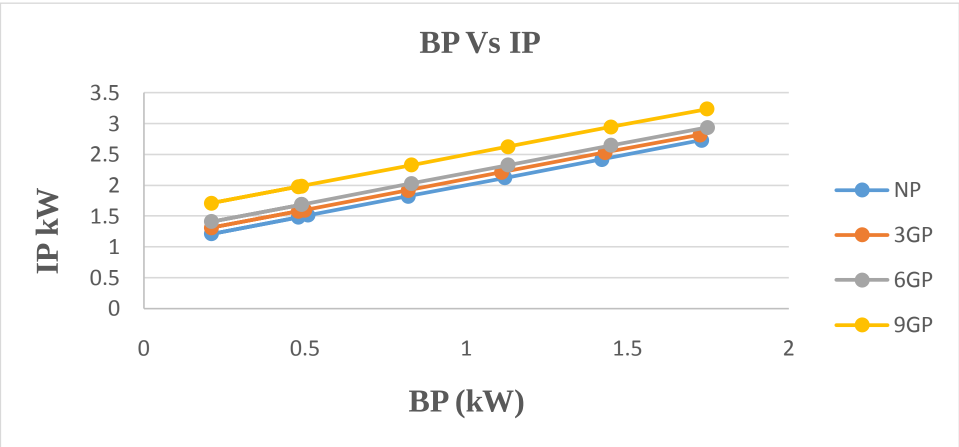

Figure7. Brake power Vs Indicated power

4. Indicated mean effective pressure:

The indicated mean effective pressure with brake power will conducted performance test on normal piston and designed grooves piston. The indicated mean effective pressure for normal piston with full load is 3.5Bar. And compared with another 3GP, 6GP and 9GP with full load 3.67Bar, 3.7Bar and 4.11Bar. As shown in Figure: 8.The indicated mean effective pressure has increased with increasing brake power. Comparison of normal piston and 9grooves piston the indicated mean effective pressure will increased up to 0.61Bar.

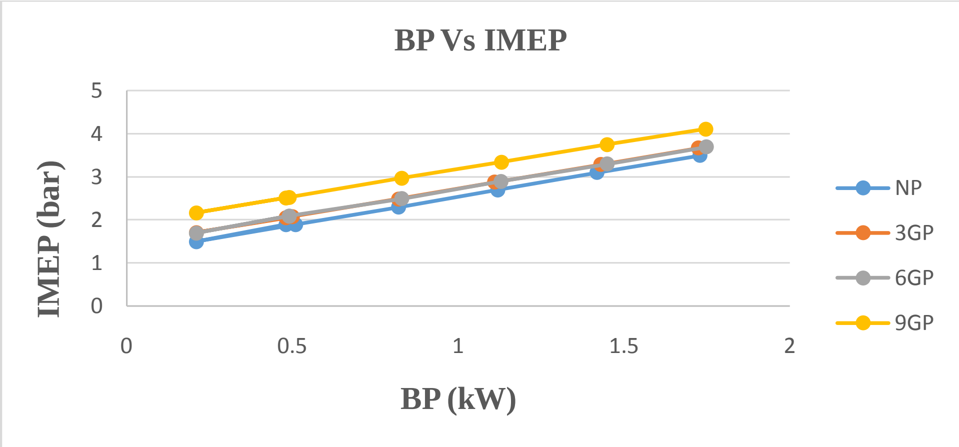

Figure8. Brake power Vs Indicated mean effective pressure

5. Brake mean effective pressure:

The brake mean effective pressure with brake power will conducted performance test on normal piston and designed grooves piston. The brake mean effective pressure for normal piston with full load is 2.27Bar. And compared with another 3GP, 6GP and 9GP with full load 2.24Bar, 2.21Bar and 2.2Bar. As shown in Figure: 9. thebrake mean effective pressure has increased with increasing brake power. Comparison of normal piston and 9grooves piston the brake mean effective pressure is remains constant.

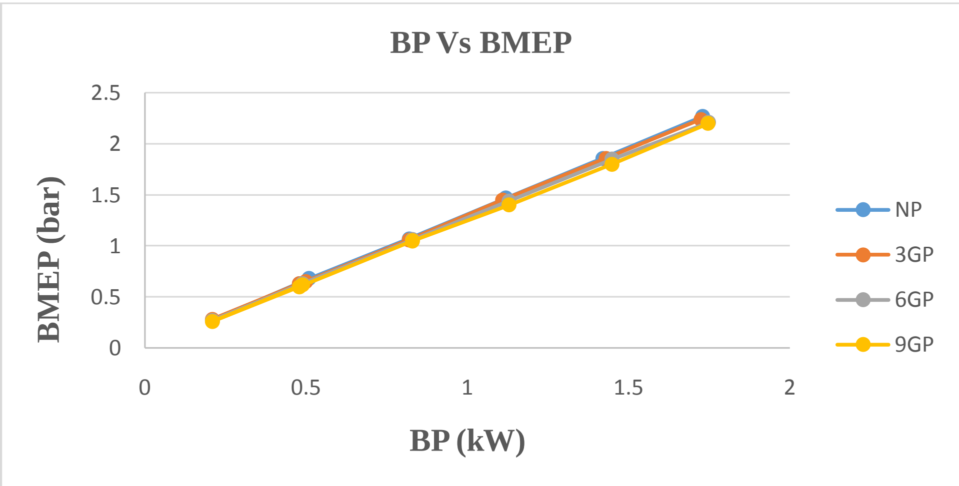

Figure9. Brake power Vs Brake mean effective pressure

6. Mechanical efficiency:

The mechanical efficiency with brake power will conducted performance test on normal piston and designed grooves piston. The mechanical efficiency for normal piston with full load is 63.3%. And compared with another 3GP, 6GP and 9GP with full load 61.1%, 59.1% and 53.7%. As shown in Figure: 10.The mechanical efficiency has decreased with increasing brake power. Comparison of normal piston and 9grooves piston the mechanical efficiency will decreased up to 9.6%.

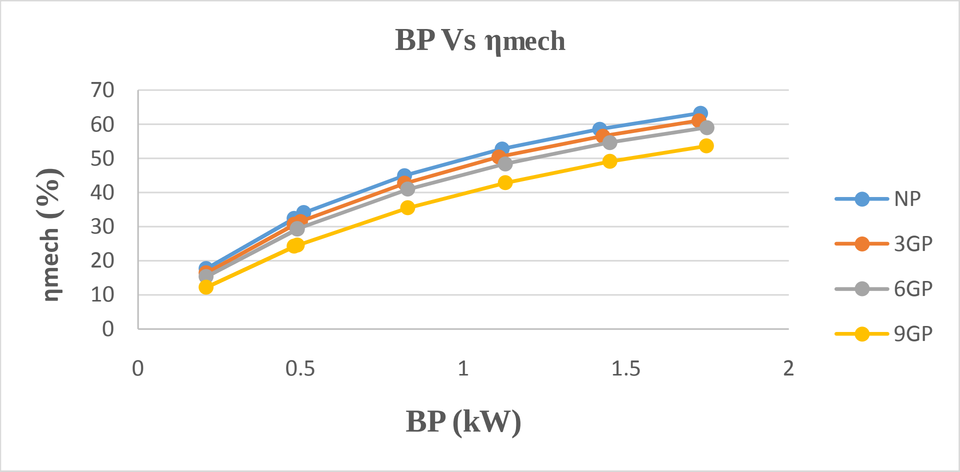

Figure10. Brake power Vs Mechanical efficiency

7. Indicated thermal efficiency:

Indicated thermal efficiency with brake power will conducted performance test on normal piston and designed grooves piston. The indicated thermal efficiency for normal piston with full load is 20.8%.And compared with another 3GP, 6GP and 9GP with full load 23.6%, 26.6% and 30.5%. As shown in Figure: 11. Indicated thermal efficiency has increased with increasing brake power. Comparison of normal piston and 9grooves piston the indicated thermal efficiency will increased up to 9.7%.

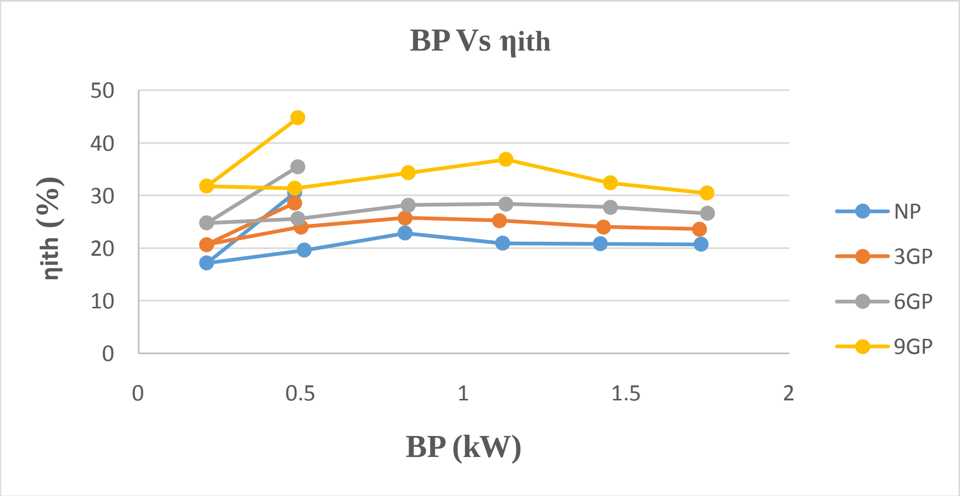

Figure11. Brake power Vs Indicated thermal efficiency

V. CONCLUSION

The configuration 3GP, 6GP and 9GP enhances the turbulence and hence better air-fuel mixing process among all three configurations of diesel engine. As a result, the mechanical efficiency of 3GP decreased from 63.3-61.1%, 6GP decreased from 63.3-59.1%, and 9GP decreased from 63.3-53.7%.Based on this investigation, the following conclusions are drawn:

- The brake thermal efficiency increased for 3GP, 6GP and 9GP compared to normal piston.
- Brake specific fuel consumption decreased for 3GP, 6GP and 9GP compared to normal piston.
- Indicated power increased for 3GP, 6GP and 9GP compared to normal piston.
- Brake power increased for 3GP, 6GP and 9GP compared to normal piston.
- Mechanical efficiency decreased for 3GP, 6GP and 9GP compared to normal piston.
- Brake mean effective pressure will be constant.
- Indicated mean effective pressure increased for 3GP, 6GP and 9GP compared to normal piston.
- Indicated thermal efficiency increased for 3GP, 6GP and 9GP compared to normal piston.

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