

FORCED ANALYSIS POCESS OF REED ROLL THREAD FOR SPARK PLUG

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ABSTRACT

Spark plug is component or device of internal combustion engine (ICE) for make a compression and transfer energy to vehicle. Component of spark plug is center electrode, gasket, hexagon, insulator, corrugation, and terminal nut, the all component will assembly for internal combustion engine component. Thread is a critical component for connection spark plug and engine. the key of perfect thread is reed roll process when the motor makes a shell of part, the forced and rpm should be stable and do not over force for eliminate failure part. This study will discuss of forced analysis on thread and structure analyze from material spark plug after process. The result show in this case using 2000 rpm and force 197,8N. Based on spot test material after threading, no any crack finding, only black dot due processing. Tortion test after assemblu 5 Kgf, for the lowest sample 1 is 8 Kgf, middle is sample 2 is 12 Kgf, and the bigger is 13 Kgf for sampling test. Igintion on sprak plug are normaly for ignition voltage lower is 13,3 kV, middle 15,3 kV, high 17,5 kV, and average is 15,3kV.

Keywords: Forced, Reed Roll, Thread, Spark Plug.

1. INTRODUCTION

Reed Roll are manufacturing process for make a product of spark plug. Spark plug have a few components like a thread, Center Electrode, Gasket, Hexagon, Insulator, Corrugation and Terminal Nut. The risk of assembly component of spark plug is thread, when the thread not locking with engine it will make decrease of compression of engine, and then will make a failure of engine. Previous research Recent advances in spark plug design and technology – a systematic review, the result is redesign of thread and will make improvement peak pressure, as the systematic observed that spark design and material are evolving rapidly to meet specification, and ultra-high lamda values and peak pressure greater than 200 bar [1]. Reliability study on spark plugs using process failure mode and effect analysis, the result show that Failure Mode and Effect Analysis (FMEA) will make safety operation the down time of improving the reliability of spark plug [2]. Fault diagnosis of spark plug in a spark ignition engine by using wavelet power spectrum, the result show that power spectra of five spark plug high a precision power than standard specification [3]. Numerical investigation of the spark plugs orientation effect on flame kernel growth, the result show that longer arc length leads to larger energy discharging rate that further influences flame kernel growth at the early stage After certain moment, the length and energy discharging rate have small influence, since its influence is approximately inversely proportional to the square of distance between arc and flame front [4]. The purpose of the research is to analyze the thread of spark plug for reed roll process based on forced process to material of thread, and analyze of structure of part after process.

2. LITERATURE REVIEW

Spark plug is component or device of internal combustion engine (ICE) for make a compression and transfer energy to vehicle. Component of spark plug is center electrode, gasket, hexagon, insulator, corrugation, and terminal nut, the all component will assembly for internal combustion engine component. Thread is a critical component for connection spark plug and engine. the key of perfect thread is reed roll process when the motor makes a shell of part, the forced and rpm should be stable and do not over force for eliminate failure part.



Figure 1. Spark Plug Components

2.1 Hydraulic and Reed Roller Thread Machine

Below figure is system of hydraulic process and roller thread machine (RRT) for processing of material spark plug for Double acting cylinder is movement process of cylinder for process thread of spark plug. DAC system operate automatically by program and DAC will control Reed Roller Thread and control rotation of dies and roll for create shell of the spark plug.

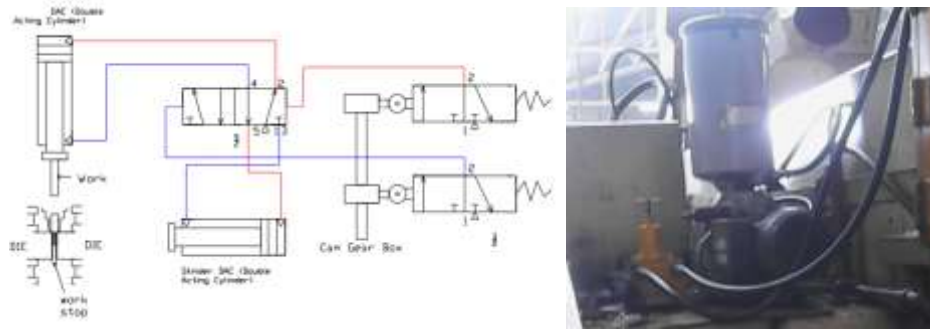


Figure 2. Spark Plug Components

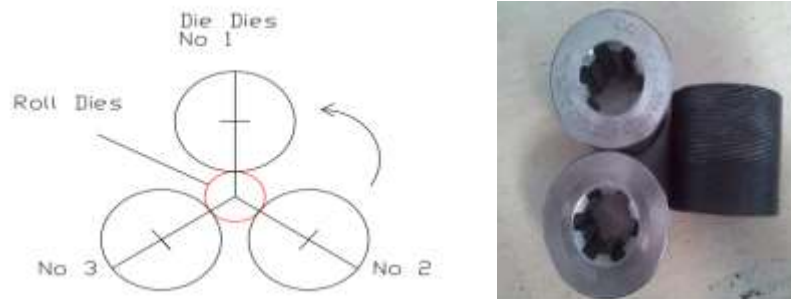


Figure 3. Roller Dies and Rotation Process

Working of dies process, when thread in center position cylinder DAC will insert with 0.5 second, after that gear box will rotate molding for make threading of spark plug in the shell. The gear box will process when cam 1 touching air valve $\frac{3}{4}$ position and DAC 1 will automatically make threading processing. After cam 1 release air cam will switch to cam 2, the cam will control the cylinder and roller.

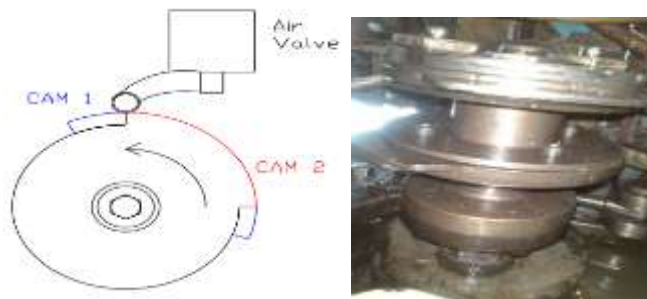


Figure 4. CAM Process

3. RESEARCH METHODOLOGY

The research method is using material nickel alloy for thread of spark plug. This material has composition aluminum dioxide 60% and iron 24%, for make a thread spark plug as refer dimension of drawing. Material will be input on machine for CAM process, when the C process was completed, will be continued for assembly process with another part and then check reliability test. analyze the thread of spark plug for reed roll process based on forced process to material of thread, and analyze of structure of part after process.

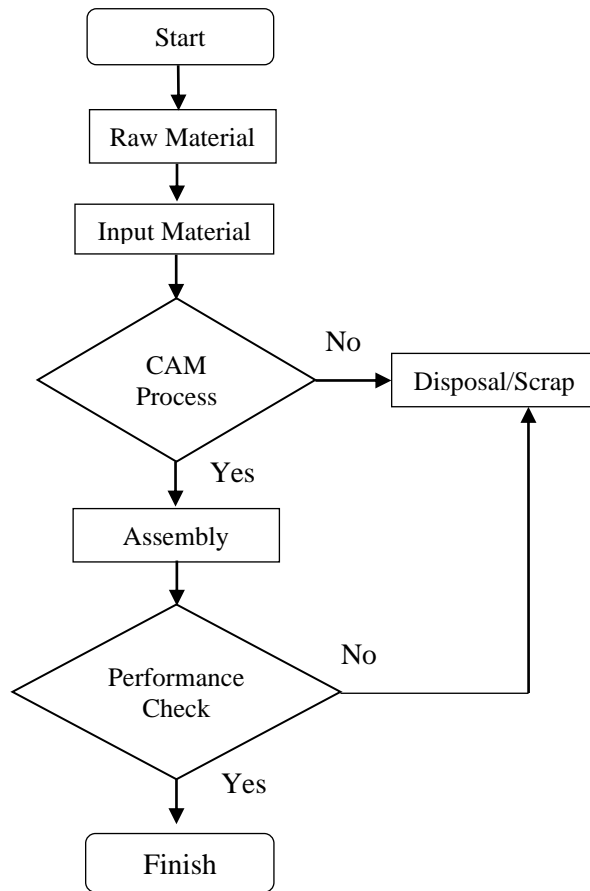


Figure 5. Research Methods

3.1 Material Composition

Spark plug develop by some composition like copper, filler, chromium, nickel, and tin. At this research stage the main material is nickel alloy with main composition is aluminum oxide 55% ~ 60% and iron 20% ~ 24%. Material will process with RRM and CAM process for make thread spark plug.

Table 1. Material Composition

No	Composition	CAS Number	Percentage
1	Copper	7440-50-8	0.3~1%
2	Filler	14807-96-6	3~5%
3	Chromium	7440-47-3	0.03%
4	Nickel	7440-02-0	3%
5	Tin	7440-31-5	0.091~1.92%
6	Iron	7439-89-6	20~24%
7	Aluminumoxide	1344-28-1	55~60%
8	Silicondioxide	1344-28-1	1~2%

No	Description	Unit	Injection Unit
3	Power	kW	0.37
4	Frequency	Hz	50
5	Voltage	V	380
6	Phase		3
7	Protection Index		IP55

The second analyze after finding rpm, need to calculate of pressure double acting cylinder (DAC) for pressure of shell on the thread. Diameter of cylinder is 0.06 m and pressure 7 bar or $7 \times 10^5 \frac{N}{m^2}$, DAC will calculate as below.

$$A = \pi . r^2$$

$$P = \frac{F}{A} \quad (2)$$

$$F = P . A$$

$$A = \pi . r^2 \text{ (m}^2\text{)}$$

$$= 3,14 . 0,03^2 = 2826 \times 10^{-3}$$

$$F = P . A = (7 \times 10^5 \frac{N}{m^2}) \times 2826 \times 10^{-3} \text{ m}^2 = 197,82 \text{ N}$$



Figure 9. DAC cylinder

4. RESULT AND DISCUSSION

Result of processing reed roll thread for spark plug is smoother when roll process based on input setting rpm and pressure on the DAC cylinder, rpm using 2000 on the motor and pressure 197,8N. The figure 10 show that thread spark plugs no any burr in finished goods, the nickel alloy material can be process used rolling method, below is figure comparison of spark plug before process and finish thread process.



Figure 10. Thread of Spark Plug

When the thread completed spot test will be make sure about condition of material after processing. Figure 11 show that the nickel alloys no any crack when material process by rolling. The material has a small black dot in the structure, the effect from increase temperature and rolling process due molding continuously process thread and should be cleaning.



Figure 11. Spot Test Material

Assembly process when thred was pass quality check the next step is check torsion of part. Figure 12 show that process of check tortion for This process is carried out to avoid the thread and insulator material from being released.



Figure 12. Torsion Check

Table 3. Injection Machine Specification





Item	Spec	Sample 1	Sample 2	Sample 3	Sample 4
Tortion Check	5 kgf ↑ (Thread loose from insulator)	8 Kgf	10,5 Kgf	12 Kgf	13 Kgf
					

Table 3 show that random sampling for spark plug for torsion test, the all part has more than 5 Kgf, for the lowest sample 1 is 8 Kgf, middle is sample 2 is 12 Kgf, and the bigger is 13 Kgf. Figure 13 show that ignition test for spark plug after assembly check, part can be making a flame core for ignition, based on table 4, the ignition voltage lower is 13,3 kV, middle 15,3 kV, high 17,5 kV, and average is 15,3kV.



Figure 13. Ignition Test

Table 4. Ignition test result

No	Data	Ignition Voltage kV
1	Sample 1	13,5
2	Sample 2	13,4
3	Sample 3	15,2
4	Sample 4	13,3
5	Sample 5	17,3
6	Sample 6	17,1
7	Sample 7	17,5
8	Sample 8	15,3
9	Sample 9	14,3
10	Sample 10	14,7
	Average	15,3

5. Conclusion

The result show that thread for spark plug can be used reed roll process. Setting of rpm and force is important for processing material, result show in this case using 2000 rpm and force 197,8N. Based on spot test material after threading, no any crack finding, only black dot due processing. Tortion test after assemblu 5 Kgf, for the lowest sample 1 is 8 Kgf, middle is sample 2 is 12 Kgf, and the bigger is 13 Kgf for sampling test. Igintion on sprak plug are normaly for ignition voltage lower is 13,3 kV, middle 15,3 kV, high 17,5 kV, and average is 15,3kV.

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