

Development of an Electronic Resin Throttle Body

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ABSTRACT

The need to improve fuel consumption by saving the weights of automobile parts is growing from the viewpoint of global warming mitigation. In the case of a throttle body for controlling the air flow volume into an engine, it is important to achieve a high dimensional accuracy of the valve-bore gap in the state of closed valve. In fact, most throttle bodies are made of precision-machined metal. Therefore, resin throttle bodies are drawing attention as a lightweight alternate. However, in comparison with metal throttle bodies, resin throttle bodies have two potential disadvantages that should be solved prior to productization. The first one is greater air leakage in the state of closed valve, and the second one is smaller heat conduction for unfreezing the valve in a frigid climate. We have developed an electronic resin throttle body that has overcome the above-mentioned disadvantages. The first disadvantage of greater leakage has been solved by the use of a world's first molding technology that allows simultaneous molding of the valve and bore with the same resin material in the same set of molding die under the same molding condition for improving the dimensional accuracy of valve-bore gap. In addition to that, the valve shape has been designed so as to increase the air-flow resistance at the valve-bore gap. The second disadvantage of smaller heat conduction has been compensated by the use of a double-bore structure for trapping the water droplets entrained in the air flow to the valve. This paper introduces the technological features of our electronic resin throttle body.

INTRODUCTION

The need to improve fuel consumption and yet to increase engine power output is growing from the viewpoint of global warming mitigation. In the case of a throttle body for controlling the air flow volume into an engine, market need for electronic throttle body is increasing for its higher accuracy in controlling the intake air flow rate in comparison with conventional mechanical throttle body. Our previous electronic throttle bodies consist of precision-machined

aluminum diecast body and brass valve. In order to meet the market need of lightweight and low cost throttle body with improved performances (lower air leakage at full-closed valve, and higher flow rate at full-open valve), we have developed and commercialized an electronic resin throttle body that is high in dimensional accuracy by molding valve and body simultaneously in the same mold cavity, and requires no precision machining.

1. OUTLINE OF ELECTRONIC THROTTLE BODY

1.1. Development History of Throttle Body

Our consistent targets are downsizing, weight saving and cost reduction while heightening the product reliability. The outstanding technological features developed for those throttle bodies are applications of non-contact sensor utilizing Hall IC, compact DC motor, and for the latest model, the use of body, valve and gear made of plastic resin.

1.2. Market Need for Electronic Throttle Body

As represented in Figure 1, the predicted improvements in 2015 compared with the respective curves between 1995 and 2006 (our start for developing resin throttle body) would be 22% in terms of fuel efficiency, and 10% in terms of engine power output. In addition to lightweight, an ideal throttle body for reaching these goals should be lower in leakage at full-close throttle in order to lower engine idle speed, and higher in flow rate at full-open throttle in order to heighten engine power output. "Leakage at full-close throttle" is a term referring to the air flow rate through completely closed valve, and it varies depending on the extent of gap between throttle bore and valve.

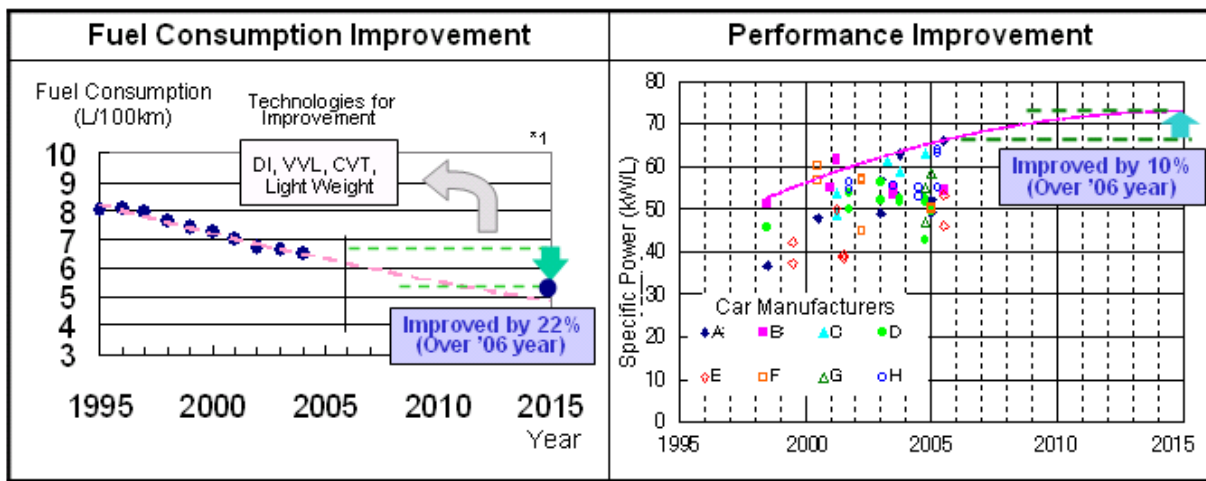


Figure 1: Trend for fuel consumption and performance

2. CHALLENGES IN DEVELOPING RESIN THROTTLE BODY

Changing the material from metals to plastic resin has reduced the weight of throttle body significantly. To attain the goals of lower cost and higher performance, the following technologies have been developed:

- Lower Cost
 - Simultaneous molding of body (bore) and valve that requires neither machining nor assembly as downstream processes.
- Higher Performance (Lower Flow Rate at Full-Close Valve)
 - Development of resin material high in molding dimensional accuracy
 - Body design that suppresses bore deformation caused by decrease in material strength
 - Increase of controllability on air flow rate by utilizing the advantages of simultaneous molding of body and valve

The gap between throttle bore and valve is key factor for designing a successful throttle body. If the material change from metal to plastic resin degrades the dimensional accuracy of valve-bore gap, and results

in a larger flow rate at full-close valve, it would also degrade the value of resin throttle body as a product. Therefore, controlling the flow rate at full-close valve is utmost importance. Another disadvantage in resin throttle body is frozen valve with water entrained in the air flow very low in temperature. Although our conventional metal throttle body has a warm water jacket to prevent valve from freezing, the method is less effective for resin throttle body as resin is smaller in heat conduction than metals. Therefore, these two disadvantages should be solved.

2.1. Technology for Controlling Air Flow Rate at Full-Close Valve

The air flow rate through throttle is expressed by the following equation:

$$Q = \alpha \cdot S \sqrt{2\Delta P / \rho}$$

Where

Q: Air flow rate, α : Flow rate coefficient, S: Gap, ΔP : Differential pressure, ρ : Density of air.

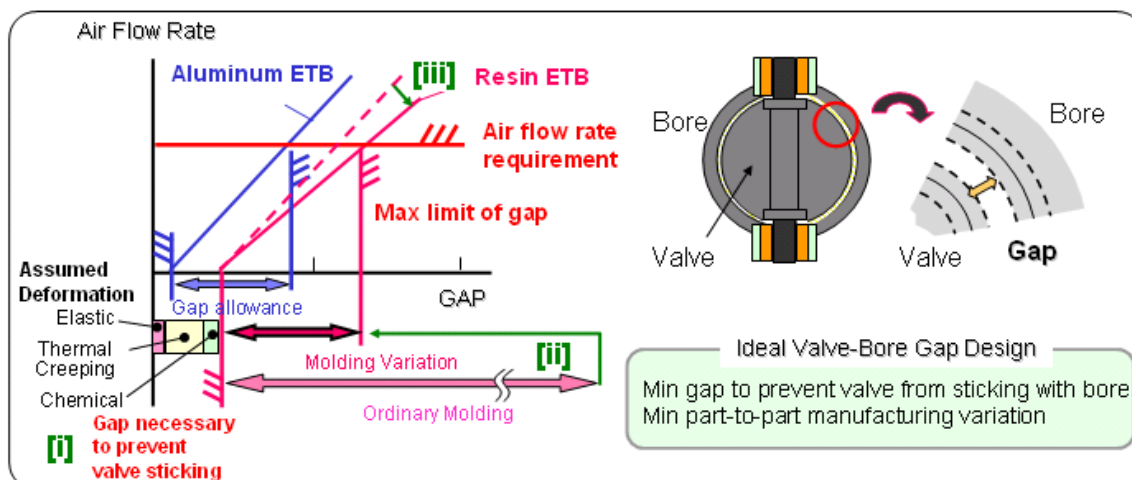


Figure 2: Gap design for valve and bore