

# Thermal and Mechanical Analysis of Intake Valve

**Mehak S. Kar**

*UG Student*

*Department of Mechanical Engineering*

*Government Engineering College, Bhavnagar (GTU), India*

**Akashkumar A. Patel**

*UG Student*

*Department of Mechanical Engineering*

*Government Engineering College, Bhavnagar (GTU), India*

**Harsh P. Pujara**

*UG Student*

*Department of Mechanical Engineering*

*Government Engineering College, Bhavnagar (GTU), India*

**Yashkumar K. Tanna**

*UG Student*

*Department of Mechanical Engineering*

*Government Engineering College, Bhavnagar (GTU), India*

## Abstract

Valves are the most important and critical part of an Internal Combustion engine. Many factors matters while designing the intake and exhaust valve of an engine such as gas inflow, material properties, oxidation characteristics, fatigue strength, thermal strength, configuration of coolant flow and cylinder head. In this, we had made the model of Inlet valve of the two wheeler in NX and had analysed it in the ANSYS. First, we had selected the different materials that were suitable for the Intake valve. After some research, we had selected two materials (SUH3, SAE1541) which can perform better for Intake valve. After this, we had performed thermal, thermal-coupled structural analysis. In this, we observed the temperature distribution over the Intake valve and deformation of Inlet valve.

**Keywords: Intake Valve Analysis, SUH3, SAE1541, Temperature, Valves**

## I. INTRODUCTION

Valves are used to control the flow of charge into the engine and removal of exhaust from the engine cylinder. They are different type of valve which is commonly used in automotive industries. 1) Poppet valve and 2) Rotary valve. Out of this poppet valve are widely used. A poppet valve is typically used to control the timing and quantity of gas or vapour flow into an engine. It has a hole in it, which is normally round or oval in shape, and also a tapered plug, usually a disk shape on the end of a shaft which is often referred as a valve stem. The portion of the hole where the plug meets with it is referred or often said as the seat or valve seat. The shaft guides the plug portion by the process of sliding through valve guide. There is a generation of spring forces on the valves which are used to open or close the valve. The valve itself consists of disc shape head having a step extending from it center one side. The edge of the head side nearest is actually grounded to 45° C degree. The advantages of poppet valve are:

- Simple in construction
- To rotate about the stem to the new position

Generally, exhaust valve is smaller in size as compared to the inlet valve because incoming charge velocity is lower as compared with exhaust velocity. Hence, low area will reduce the significant thermal loading.

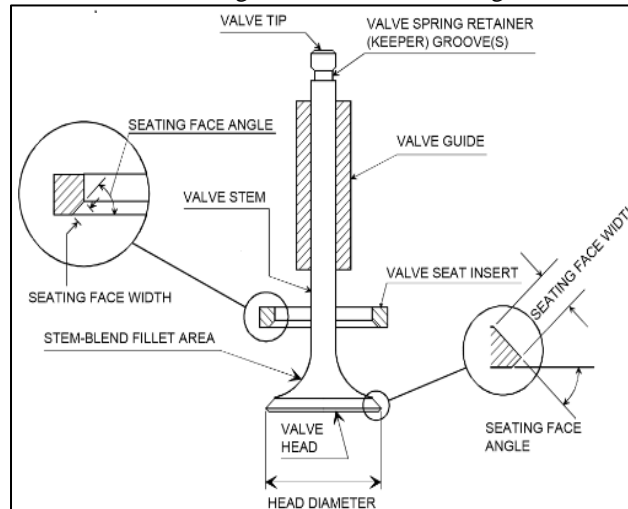


Fig. 1: Valves

## II. MATERIAL SELECTION

To select the good material for the Intake valve, material should fulfil the following requirements:

- High strength and hardness
- Should sustain itself at high temperature
- Resistance to oxidation and corrosion
- Fatigue and Creep resistance should be high

### A. Material Suggested

#### 1) JIS-SUH3

This material is Martensitic Steel, which is hard below 500° C and is used, in the mid temperature range and which is generally used for Intake valve. Due to the presence of 11% Chromium, it has the good corrosion resistance.

#### 2) SAE 1541

This material has good hardenability and tensile strength. Due to the presence of Manganese, it decreases the critical cooling rate during hardening.

Table - 1  
Various properties of materials used

Valve Material Name	Martensitic heat-resistant steel JIS-SUH3	Martensitic heat-resistant steel SAE 1541
% of Carbon	0.4	0.40
% of Silicon	2	0.23
% of Manganese	0.6	1.50
% of Nickel	0.6	-
% of Chromium	11	-
% of Molybdenum	1	-
% of Iron	Balance	Balance

## III. MODELLING AND ANALYSIS RESULTS

### A. Assumptions

- The valve material is homogeneous and isotropic.
- Inertia and body forces are neglected.
- Analysis is based on pure thermal loading and structure.
- The Intake valve model is of Solid type.
- The thermal conductivity of the material used for analysis is constant throughout.
- The specific heat of the material is constant throughout and does not change with the change in temperature.
- Under normal operation when the valve is properly seated on the Inserts, stresses generated from the seating are moderated. They could be very high when the valve train are improperly engineered.

### B. 3D Model of Intake Valve

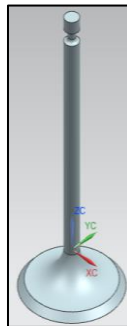


Fig. 2: 3d model of intake valve

### C. Temperature Distribution

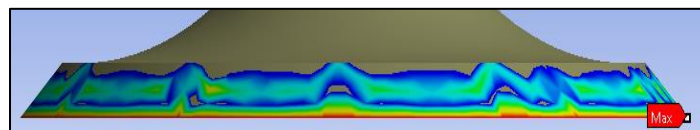


Fig. 3: Temperature Distribution in Jis-Suh3

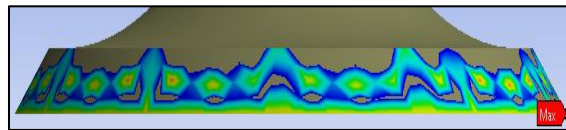


Fig. 4: Temperature Distribution in SAE 1541

#### D. Total Deformation

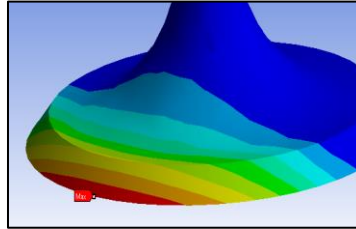


Fig. 5: Deformation in Intake Valve using Material JIS-SUH3

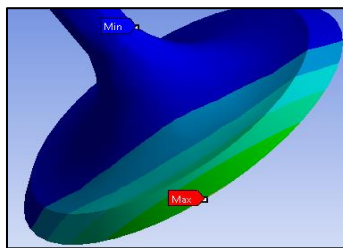


Fig. 6: deformation in inlet valve using material SAE 1541

#### IV. ADVANTAGES OF MATERIALS (SUH3 AND SAE 1541)

- The cost of these materials is very low as compared to the super alloys and satellite.
- Both material gives good heat resistance.
- JIS-SUH3 has good hardenability below 500° C which makes it good material for Intake valve.

#### V. DISADVANTAGES OF MATERIALS (SUH3 AND SAE 1541)

- These materials cannot perform well above 600° C.
- These materials have Martensitic structure, which loses its hardenability at high temperature.
- These materials do not have enough strength to for manufacturing of exhaust valve.

#### VI. CONCLUSION

After analysing both the materials, we conclude that JIS-SUH3 performs well when compared with SAE 1541. It has good heat transfer property and low thermal expansion. Due to good heat transfer, property JIS-SUH3 the total deformation is less as compared to SAE 1541.

Table – 2  
SAE 1541

Valve Materials	JIS-SUH3	SAE 1541
Total Deformation Strain (mm)	0.30345	0.32669

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