Vikas Engine

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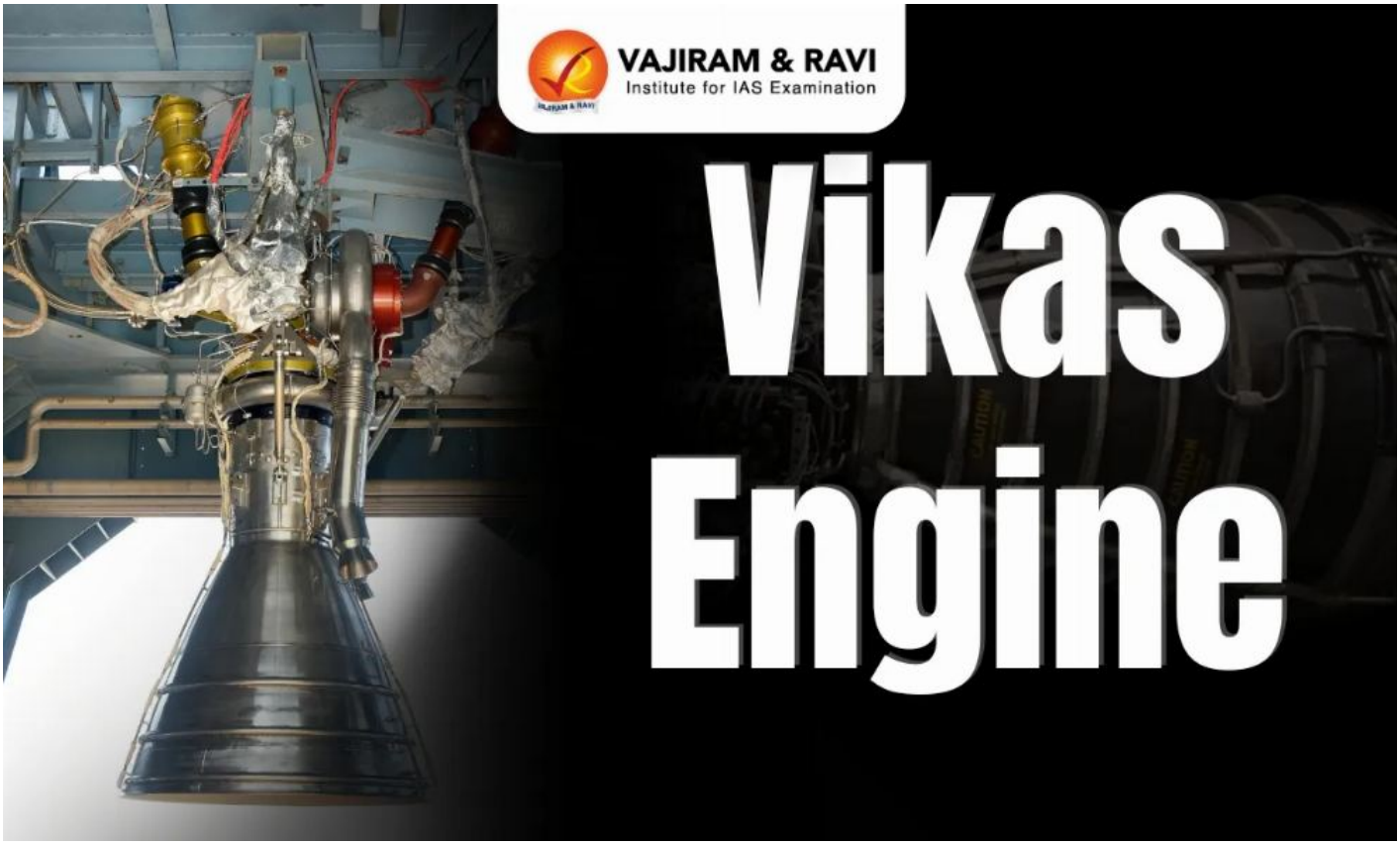

The **VIKAS Engine**, named in honour of **Vikram Ambalal Sarabhai**, is a family of liquid-fueled rocket engines that was conceived and developed by the Liquid Propulsion Systems Centre of ISRO during the 1970s. Initially, these engines incorporated imported French components, which were later replaced with domestically manufactured counterparts. The design of the Vikas Engine drew inspiration from the European Viking Engines.

These engines have applications in the Core Stage (Liquid Propulsion) of ISRO's Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous Satellite Launch Vehicle (GSLV). The **fuel capacity** of the Vikas engine is **40 tonnes** for the PSLV, GSLV Mark I and II, and **55 tonnes** for the GSLV Mark III.

History of Vikas Engine

The history of the development of Vikas engine goes back to the 1970s when the **Liquid Propulsion Systems Centre of ISRO** developed Vikas Engine.

- The technology for the Vikas engine was transferred from Societe Europeenne de Propulsion in 1974.
    - It is a French Aerospace engine manufacturer, a subsidiary of **Safran,** with which HAL has **recently** signed a **MoU** in 2023.
- The first engine was built using acquired technology. It was tested successfully in 1985.

Working of Vikas Engine

The Vikas engine plays a crucial role in powering the **second stage of the PSLV**, as well as the boosters and second stage of the **GSLV Mark I and II**. It also serves as the **core stage** engine for **LVM3**.

- Propellant loading specifications differ, with **PSLV** and **GSLV Mark I and II** utilizing 40 tonnes, while **LVM3** requires 55 tonnes.
- The Vikas engine operates on a combination of **40 metric tonnes of Unsymmetrical Dimethylhydrazine (UDMH)** as the fuel and **Nitrogen Tetroxide (N2O4)** as the oxidizer. It achieves a maximum **thrust** of **725 kN.**

Fuels

- **UDMH:** Itis a **hypergolic** (ignites spontaneously when mixed with another component of the fuel) rocket fuel.
    - The second component is usually **dinitrogen tetroxide (N2O4)** which acts as an oxidiser.
    - UDMH is generally preferred to **hydrazine (N2H4)** in rocket fuels because it auto-ignites at a higher temperature and is thus **more stable** in storage.
- **UH 25**: It is a mixture of 75% **UDMH** and 25% **hydrazine (N2H4)**.

Types of Vikas Engine

There are different types of Vikas Engines. Some of them are already developed and some are under-development stage. There are two main types of Vikas engines:

- **HTVE (High Thrust VIKAS Engine):** The HTVE are **modified VIKAS-2B** engines.
    - This engine has a chamber pressure of 62 bar, which is 6% higher than the older version of the engine.
    - This gives it a thrust of 800 kN. The HTVE engine is used for the **second stage** of the GSLV.
- **HPVE (High Pressure or High-Speed VIKAS Engine):** This engine is still under development.
    - It is a significantly **modified version** of the Vikas engine with a **higher chamber pressure and thrust.**
    - The HPVE engine is being developed for the GSLV booster and the first stage of the future LVM3 (M).

Variants of Vikas Engine

The following are the different variants of the Vikas Engine:

Type	Fuel	Launcher Stages
Booster/first stage		
Vikas-2	UDMH / N2O4	GSLV Mk-I L40H Strapon
Vikas-2B	UH 25 / N2O4	GSLV Mk-II L40H Strapon
Vikas-X	UH 25 / N2O4	LVM3 L110 stage
Second stage		
Vikas-4	UDMH / N2O4	GSLV Mk-I GS2 stage, PSLV PS2 stage
Vikas-4B	UH 25 / N2O4	GSLV Mk-II GS2 stage, PSLV PS2 stage

Throttling Test of Vikas Engine

The first throttling test for the Vikas Engine took place in January 2023, successfully achieving a targeted **67 percent thrust level** for a duration of **43 seconds**.

- **Throttling** means **controlling** the jet’s thrust level by managing the flow rate of the fuel.
- Setting the power at 67 per cent enables the satellite to **finely tune** its **speed** and **trajectory**, facilitating precise corrections to its orbital path.
- The **significance** of the 67% specific thrust level depends on the **engine design and prevailing conditions**, usually **indicating a reduced thrust** compared to the engine's maximum capability.
- The **throttling period** for a liquid propellant satellite engine refers to the **amount of time for which the engine is running at a reduced thrust**.
- Throttling is instrumental in adjusting the spacecraft's **speed** and **orientation** by modifying the engine's thrust level.
- The duration of throttling varies based on mission requirements and motor design.
    - For example, a 67 percent thrust level may be sustained for 43 seconds.

VIKAS Engine for Gaganyaan Programme

The VIKAS engine is going to take forward India's pioneering Gaganyaan Mission, marking the country's **first manned space initiative**.

- A **high-thrust variant** of the Vikas Engine specifically designed for the Gaganyaan mission underwent a **successful test-firing** lasting **25 seconds** at ISRO's Propulsion Complex (IPRC) in Mahendragiri.
- The purpose of the test was to **assess the engine's resilience** under conditions exceeding its normal operating parameters.
- The engine not only **met the test objectives** but also **exhibited close alignment** between predicted and actual parameters throughout the entire duration of the test.
- The **Test Vehicle Abort Mission (TV-D1)** is a crucial aspect of the Gaganyaan program, designed to execute a **high-altitude abort** in the event of **anomalies during launch or post-launch**.
    - The TV-D1 vehicle is equipped with a **modified VIKAS engine**, featuring the Crew Module and Crew Escape System attached to its fore-end.