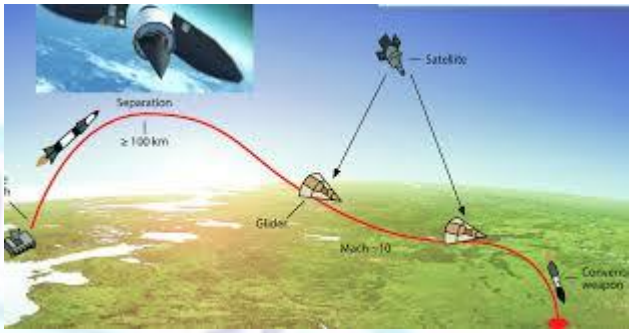
6. Hypersonic Missiles – I R

Defence Research and Development Organisation (DRDO) has achieved a key milestone in the development of hypersonic missiles

DRDO's Scramjet Breakthrough and Hypersonic Missile Development

Recent Development - Scramjet Ground Test

Key Highlights



The Defence Research and Development Organisation (DRDO) successfully conducted a long-duration ground test of an Actively Cooled Scramjet Full-Scale Combustor. The test was carried out at the Scramjet Connect Pipe Test (SCPT) facility, a highly advanced hypersonic testing infrastructure. The test achieved a continuous run time of over 12 minutes, which is considered a path-breaking milestone globally. This duration is significant because sustaining supersonic combustion for long periods is one of the most complex challenges in hypersonic propulsion. The test was conducted by the Defence Research and Development Laboratory (DRDL), Hyderabad.

Strategic Significance of the Test

1. Demonstrates India's capability in air-breathing hypersonic propulsion.
2. Validates thermal management technologies, especially active cooling, required to withstand extreme temperatures (over 1,000°C).
3. Marks progress toward operational hypersonic cruise missiles, not just experimental prototypes.
4. Places India among a select group of nations with advanced scramjet capabilities.

Understanding Hypersonic Missiles

Hypersonic Missiles

Hypersonic missiles travel at speeds greater than Mach 5 (five times the speed of sound). This corresponds to speeds exceeding 6,100 km/hr. They maintain these speeds for extended durations, unlike short high-speed boosts in conventional missiles.

Key Features

Extreme Speed - Compresses enemy reaction time.

High Maneuverability - Ability to change trajectory mid-flight.

Low Detectability - Flies at lower altitudes than ballistic missiles.

Defence Penetration - Difficult to intercept using existing missile defence systems.

Role of Scramjet Technology

Scramjet

Scramjet stands for Supersonic Combustion Ramjet. It is an air-breathing engine that -

1. Takes in atmospheric oxygen.
2. Burns fuel while airflow remains supersonic.

Unlike rockets, scramjets do not carry oxidisers, reducing weight and increasing efficiency.

Why Scramjets Matter

1. Enable sustained hypersonic flight.
2. Improve range and endurance of hypersonic cruise missiles.
3. Reduce launch cost compared to rocket-based systems.

Types of Hypersonic Weapon Systems

Hypersonic Glide Vehicles (HGVs)

1. Launched using a rocket booster.
2. After separation, the vehicle glides unpowered at hypersonic speeds.
3. Follows a non-ballistic, unpredictable trajectory.
4. Difficult to track using conventional radar systems.

Hypersonic Cruise Missiles (HCMs)

1. Powered throughout flight by scramjet engines.
2. Fly within the atmosphere at sustained hypersonic speeds.
3. Offer greater control, accuracy, and maneuverability than HGVs.
4. DRDO's current scramjet work is primarily aimed at HCM development.

Missile Systems in India - A Comparative Overview

Ballistic Missiles

Follow a ballistic trajectory, leaving and re-entering the atmosphere. Primarily serve strategic deterrence roles. Capable of carrying conventional or nuclear warheads.

Categories in India

Short-Range Ballistic Missiles (SRBM)

1. Prithvi-I
2. Prithvi-II
3. Prithvi-III

Medium to Long-Range Ballistic Missiles (MRBM/IRBM)

1. Agni-I
2. Agni-II
3. Agni-III
4. Agni-IV
5. Agni-V

Cruise Missiles

1. Use aerodynamic lift and fly within the atmosphere.
2. Known for high precision and flexibility.
3. Typically used for tactical and precision strike roles.

Key Indian Cruise Missiles

Nirbhay - Long-range, subsonic cruise missile.

BrahMos - Supersonic cruise missile. One of the fastest operational cruise missiles in the world.

Hypersonic Missiles vs Ballistic & Cruise Missiles

Comparative Advantages

Faster than cruise missiles and more maneuverable than ballistic missiles.

Combine -

1. Speed of ballistic missiles
2. Precision of cruise missiles

Significantly reduce the effectiveness of -

1. Missile defence shields
2. Early warning systems

Strategic and Geopolitical Implications

Military Significance

1. Enhances India's deterrence credibility.
2. Strengthens conventional strike capabilities without nuclear escalation.
3. Acts as a counter to hypersonic advancements by China and Russia.

Technological Spin-offs

Advances in -

1. Materials science
2. Thermal protection systems
3. Computational fluid dynamics

Potential civilian applications in -

1. Space launch systems
2. Reusable launch vehicles
3. High-speed aerospace transport

Conclusion

DRDO's successful long-duration scramjet test represents a critical leap in India's hypersonic weapons programme. It signals India's transition from experimental hypersonic research to near-operational capability. Hypersonic missiles will play a central role in future warfare, redefining deterrence, defence planning, and strategic stability. Continued investments in propulsion, materials, and testing infrastructure will be crucial for full weaponisation.

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