China's 'Artificial Sun' EAST

Why in News

Recently, China's **Experimental Advanced Superconducting Tokamak (EAST)** achieved a peak temperature of **288 million** degrees Fahrenheit, which is over **ten times hotter** than the sun.

- **China is not the only country** that has achieved high plasma temperatures. In 2020, **South Korea's KSTAR (Korea Superconducting Tokamak Advanced Research) reactor** set a new record by maintaining a plasma temperature of over 100 million degrees Celsius for 20 seconds.

Tokamak

- The tokamak is an **experimental machine** designed to harness the **energy of fusion.**
- Inside a **tokamak**, the energy produced through the fusion of atoms is absorbed as heat in the walls of the vessel.
- Like a conventional power plant, a **fusion power plant uses** this heat to produce steam and then electricity by way of **turbines and generators.**

Key Points

- **About:**
  - The EAST reactor is **an advanced nuclear fusion experimental research device** located at the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) in Hefei, China.
- **Establishment:**
  - EAST first became operational in 2006.
- **Purpose:**
  - The purpose of the artificial sun is **to replicate the process of nuclear fusion, which is the same reaction that powers the sun.**
  - This is part of the **International Thermonuclear Experimental Reactor (ITER)** facility, which will become the world's **largest** nuclear fusion reactor when it becomes **operational in 2035.**
    - The **ITER Members** include China, the European Union, **India**, Japan, Korea, Russia and the United States.
- **Working:**
  - It is **based on the Nuclear Fusion Process** that is carried out by the Sun and the Stars.
  - For nuclear fusion to occur, **tremendous heat and pressure are applied on hydrogen atoms** so that they fuse together. The **nuclei of deuterium and tritium** - both found in hydrogen - are **made to fuse together** to **create a helium nucleus**, a neutron along

with a whole lot of energy.
    - The gaseous hydrogen fuel **is heated to temperatures of over 150 million degrees Celsius** so that it **forms a hot plasma** (electrically charged gas) of **subatomic particles.**
    - With the help of a strong magnetic field, the plasma is kept away from the walls of the reactor to ensure it does not cool down and lose its potential to generate large amounts of energy. The **plasma is confined for long durations for fusion to take place.**
- **Other Tokamaks in China:**
    - Apart from the EAST, China is currently operating the **HL-2A reactor** as well as **J-TEXT.**
    - In **December 2020,** HL-2M Tokamak, China's largest and most advanced nuclear fusion experimental research device, was successfully **powered up for the first time** — a key milestone in the **growth of China's nuclear power research capabilities.**
- **Significance:**
    - It is significant as far as **China's Green Development** is concerned.
    - **Nuclear fusion** is a process through which **high levels of energy are produced without generating large quantities of waste.** Unlike fission, fusion **also does not emit greenhouse gases** and is considered a safer process with lower risk of accidents.

Nuclear Reactions

- **Description:**
    - A nuclear reaction is the process in which **two nuclei, or a nucleus** and an **external subatomic particle**, collide to produce **one or more** new nuclides.
    - Thus, a nuclear reaction must cause **a transformation** of at least one nuclide to another.
- **Types:**
    - **Nuclear Fission:**
        - The nucleus of an **atom splits** into **two daughter nuclei.**
        - This decay can be **natural spontaneous splitting** by radioactive decay, or can actually be simulated in a lab by achieving necessary conditions (bombarding with neutrons, alpha particles, etc.).
        - The resulting fragments tend to have a combined mass which is less than the original. The **missing mass** is usually converted into **nuclear energy.**
        - Currently **all commercial** nuclear reactors are based on **nuclear fission.**
    - **Nuclear Fusion:**
        - Nuclear Fusion is defined as the **combining of two lighter nuclei** into a **heavier one.**
        - Such nuclear fusion reactions are the source of energy in the Sun and other stars.
        - It takes considerable energy to force the **nuclei to fuse.** The conditions needed for this process are extreme – **millions of degrees** of temperature and millions of pascals of pressure.
            - The **hydrogen bomb** is based on a thermonuclear fusion reaction. However, a nuclear bomb based on the fission of uranium or plutonium is placed at the core of the hydrogen bomb to provide initial energy.

Source: IE