New Technique for Monitoring of Power Transmission Cables

Why in News

Recently, researchers at IIT Madras have demonstrated that **power transmission cable** can be monitored by using **Raman thermometry** on the **fibre optic cable.**

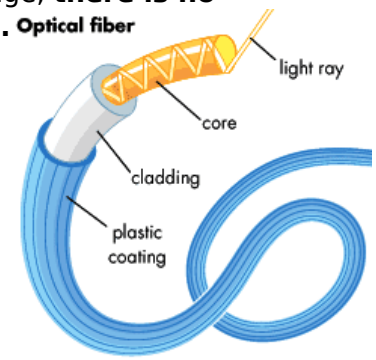
- They achieved this by **using the optical fibres that are already embedded** in the power cables for establishing optical communication.

Key Points

- **Raman Thermometry:**
    - It is a **thermal characterization technique** which makes use of **Raman scattering phenomena** to **determine the local temperature** in microelectronics systems.
    - **When light is scattered off an object,** say a molecule, **two bands are observed,** with higher and lower frequency than the original light, called the **Stokes** and **anti-Stokes bands,** respectively.
    - By studying the **relative intensity** of the two bands, it is **possible to estimate the temperature** of the object which scatters the light.
        - The **anti-Stokes** component of Raman scattering is **strongly dependent on the temperature** that the material is subjected to. Thus, by **measuring the intensity of the anti-Stokes scattered light we can estimate the temperature.**
    - Any current flowing through a conductor would cause a temperature rise due to the **Joule heating effect.** Hence the flow of current through the power cables results in heating of the power cables.
        - **Joule heating** (also referred to as resistive or ohmic heating) describes the process where the **energy of an electric current is converted into heat** as it flows through a resistance.
- **Optical Fibre Technique:**
    - The temperature measurement of wires is performed in not just one location, but in a distributed manner using an **optical fibre.** To achieve this, **a pulse of light** is launched into the optical fibre and the backscattered radiation is observed.
        - Optical fibres are **fabricated with high quality composite glass/quartz fibres.**
            - Each fibre consists of a **core (denser)** and **cladding (rarer).**
        - When a signal in the form of light is directed at one end of the fibre at a suitable angle, it undergoes repeated **total internal reflections** along the length of the fibre and finally comes out at the other end.
            - **Total internal reflection** is **complete reflection of a ray of light** within

a medium such as water or glass from the surrounding surfaces back into the medium.

- Since light undergoes total internal reflection at each stage, **there is no appreciable loss in the intensity of the light signal.**



  - The time of flight of the **backscattered radiation provides an estimate** of the distance from which the light is backscattered.

    - **Backscattering** (or backscatter) is the reflection of waves, particles, or signals back to the direction they came from.
    - This constitutes a distributed measurement as the pulse propagates all along the length of fibre.
    - This can go up to tens of kilometers.

- **Significance:**

  - **Actual Temperature Measurements:**

    - The use of Raman thermometry technique allows the operators to **get the results for actual temperature measurements** over tens of kilometres.

  - **Economic and Real-Time:**

    - Alternative methods of measuring the temperature of power cables include using a **thermal camera** which is cumbersome. The present method devised by the team is both **economical and provides real-time information.**

      - **Thermal cameras** detect temperature by recognizing and capturing different levels of **infrared light.**

Raman Effect

- The Raman Effect or Raman Scattering is a **phenomenon in spectroscopy** discovered by the eminent physicist **Sir Chandrasekhara Venkata Raman in 1928.**

  - In 1930, he got a **Nobel Prize** for this remarkable discovery and this was the **first Nobel Prize for India in the field of Science.**

- The Raman Effect is a **change in the wavelength of light** that occurs when a light beam is deflected by molecules. When a beam of light traverses a dust-free, transparent sample of a chemical compound, a small fraction of the light emerges in directions other than that of the incident (incoming) beam.
- Most of this scattered light is of **unchanged wavelength.** A small part, however, has wavelengths different from that of the incident light; its presence is a result of the Raman Effect.

Source:TH