Tech and engineering

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Topic 2

Tech and sustainability

Sustainable development

Effectively use resources available today without compromising the future.

Sustainable technology

They minimise the environmental impact of activities through reusing, recycling, and reducing the use of resources and energy. They contribute towards SDGs.

Technical contributions

- Energetic efficency
  - Sensors can reduce energy consumption.
- Renewable energy
  - They generate clean, reliable energy.
- Environmental control
  - Sensors allow quality checking, and thus improvements.
- Circular economy
  - Maximise the reincorporation of materials into the production chain.
- Sustainable product development
  - E.g. nanotech creates more environmental-friednly products.

Tech trends towards the environment

These are only applicable if policies are implemented to regulate them. They are also very dependent on the population's awareness.

- Reneweable energies
  - They reduce greenhouse gases; research is being done into their distribution and storage.
- IoT
  - They optimise the use of resources by means of a more intelligent net of control.
- Blockchain
  - They authenticate immutable registres for processes and products.
- AI
  - They provide resource optimisation and pattern identification for easier decision-making.
- Circular economy
  - The idea of reincorporation is being implemented through e.g. 3D printing.
- Sustainable mobility
  - Electric vehicles, public transport, and shared mobility reduce the environmental impact of transportation.

Sustainable materials

- They don't deplete natural resources.
- Their emissions are lower.
- Their waste is lower.
- They can be reused or recycled.

Types of sustainable materials

- Recyclable, they can be given a different use.
- Biodegradable, they can be decomposed by natural processes.
- Reusable, they can be used again for the same purpose.
- Vegetal, they come from renewable sources that spend less energy and leave less waste.

Pros of sustainable materials

- Water and air are better preserved, because toxins are released less often.
- Energy savings are higher.
- They preserve the environment because they don't deplete natural resources.
- They reduce waste and allow for recycling and reuse.

Woods

They are generated from the leftovers in the sawmill.

Types of woods

- Laminated, they are made from thin layers of grain.
- Chipboard, they are made from crushed chips.
- Fibreboard, they are made from pressed fibres.
- Striped board, they are made from glued pieces of the same wood.

Properties of materials

- Sensory properties, they are perceived by the senses.
- Thermal properties, they are the materials' response to heat.
- Magnetic properties, they are the materials' capacity to be attracted by a magnet.
- Technological properties, they are the materials' response to production processes.
  - Fusibility, they are the materials' capacity to be melted.
  - Ductility, they are the materials' capacity to be stretched in threads.
  - Malleability, they are the materials' capacity to be shaped into thin layers.
  - Plasticity, they are the materials' capacity to be shaped without breaking.
- Ecological properties, they are the materials' harmfulness to the environment.

Chemical properties

- Chemical stability, the compound's need for an external agent to react or the result of the reaction with another compound.
- Oxidation, the reaction with oxygen accelerated by heat provides protection against corrosion.
- Corrosion, oxidation in a humid environment or with aggresive substances.

Physical properties

- Density, the mass per unit of volume.
- Electrical resistance, the opposition to the passage of electric current measured in ohms, resistivity and conductivity; the materials can be conductors, semiconductors or insulators.
- Optical properties, the materials' response to light; they can be transparent, translucent, or opaque.

Mechanical properties

- Hardness, the materials' resistance to being scratched or cut.
- Tenacity, the materials' resistance to breaking when hit; the lesser ones are fragile.
- Flexibility, the materials' capacity to be bent without breaking; the lesser ones are rigid.
- Elasticity, the materials' capacity to return to their original shape after being deformed; the lesser ones are plastic.

Destructive tests

Tensile test

It uses a stress-strain diagram.

- Tensile force F (in N, kgf, or kp).
- Elongation
  $\Delta L = L - L_0$ (in mm)
  $\epsilon = \frac{\Delta L}{L_0}$ (non-dimensional).
- Strain
  $\sigma = \frac{F}{S_0}$ (in Pa, $\mathrm{N/mm^2}$, $\mathrm{kp/cm^2}$)
  $\sigma = E$ (modulus of elasticity) $\cdot \epsilon$ (only in the proportional area).
- Max elongation $A\,(\%) = 100\left(\frac{L_f - L_0}{L_0}\right)$.

- Area of a cylindre $\pi r^2 = \pi \frac{d}{2}^2$.
- Area under the line...
  - Under the tensile test $\rightarrow$ Tenacity.
  - Under the elastic limit $\rightarrow$ Resillience.
  - Under the force-elongation curve $\rightarrow$ Work.
  - Ductility % relative elongation $\rightarrow$ Plastic deformation until fracture.
  - Rigidness $\rightarrow$ Plastic deformation until fracture; proportional to E.
- Maximum tensile force $\rightarrow$ Maximum charge limit on a material smaller than the tensile tension on the proportionality limit.
  - The material doesn't suffer plastic deformation.
  - The material abides by Hook's law.
  - The process's security is more asured.
- Coefficient of secutiry $\rightarrow n = \frac{\sigma_f}{\sigma_w}$, where σ_f is the creep stress and σ_w is the work stress.

Hardness test

- Brinnel
  - Not too hard materials.
  - Tempered steel ball.
  - Measures the diameter of the indentation on mid-size materials.
  - $HB = \frac{F}{S} = \frac{2F}{\pi D\left(D - \sqrt{D^2 d^2}\right)}$ (in $\frac{kp}{mm^2}$).
  - Expressed in HB, mm, kp, s.
- Rockwell
  - Hard and soft materials.
  - Diamond cone or steel ball.
  - Measures the depth of the indentation and is the quickest.
  - Soft materials $\rightarrow HR = 100 - e$
    Hard materials $\rightarrow HR = 130 - e$
    where e is the permanent indentation.
- Vickers
  - Very hard materials.
  - Diamond pyramid.
  - Measures the diameter of the indentation and is very expensive.
  - $HV = \frac{1.854F}{d^2}$ (in $\frac{kp}{mm^2}$).

Resillience test

- Charpy test.
- Test piece 10×10 mm, $L = 55$ mm with 2 mm U/V serration ($S_0 = 80$ mm^2).
- $\rho = \frac{mg(h_0 - h_f)}{S}$ (in $\frac{J}{m^2}$).

Fatigue test

The material is subjected to cycli loads without reaching the breaking point. The most common one is the rotative bending test. Steel and other materials have a fatigue limit around 0.4 - 0.5.

Non-destructive tests

Ultrasonic test

- Uses high-frequency sound waves.
- A transducer applies sound waves into the steel. The sound waves travel through the material and reflect back if there's a discontinuity.
- Detects internal flaws, measures thickness, and finds changes in material properties.

Radiographic test

- Uses X-rays or gamma rays.
- Radiographic films are exposed to a radiation source passed through the steel. The film shows the internal structure based on varying radiation absorption levels.
- Identifies internal defects like cracks, voids, and inclusions.

Magnetic particle test

- Magnetic induction.
- The steel is magnetized. Fine magnetic particles are applied to the surface, which gather at discontinuities, visible under proper lighting conditions.
- Detects surface and slightly subsurface discontinuities in ferromagnetic materials.

Eddy Current test

- Electromagnetic induction.
- Alternating current is passed through a coil, creating an alternating magnetic field that induces eddy currents in the conductive steel. Variations in the eddy current flow are monitored to detect flaws.
- Detects surface and near-surface defects, measures coating thicknesses, and conducts conductivity measurements.