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Department of Electrical Engineering **Year of study:** 3rd year Bachelor's degree
Option: Renewable Energy and Environment

Tutorial Session No. 2.

Exercise 1 :

A flat-plate solar air collector has the following characteristics:

- Absorber surface area: **2 m²**
- Solar irradiance: **800 W/m²**
- Air mass flow rate: **0.02 kg/s**
- Inlet air temperature: **25°C**
- Outlet air temperature: **45°C**

Tasks:

1. Calculate the useful thermal power (**Q_a**) delivered by the collector.
2. Determine the **instantaneous thermal efficiency (η_t)**

Exercise 2 :

For a flat-plate solar collector with a surface area A=2.00 m^2. The following experimental measurements were recorded (values adjusted to obtain physically consistent results):

Measurement	G (W/m²)	Tm−Ta (K)	Qu (W)
1	800	20	960
2	600	10	780
3	1000	25	1200
4	900	18	1134
5	700	12	906

The instantaneous thermal efficiency of the collector is defined by the linear relation:

$$\eta = \eta_0 - \alpha_1 \frac{(T_m - T_0)}{G}$$

Tasks:

Using the above experimental data, determine by **linear regression** the parameters:

- the **optical efficiency** η_0
- the **heat loss coefficient** α_1

Exercise 3 :

A solar still of the "single basin still" type has a basin surface area of **$A = 1\ m^2$**. The incident solar radiation is **$G = 800\ W/m^2$**. Over the course of one hour, a quantity of **$m = 0.5\ kg$** of distilled water is collected. The latent heat of vaporization is **$L = 2.26\times10^6\ J/kg$**. Thermal losses (convection, conduction, radiation) are assumed to be non-negligible.

1. Calculate the solar energy received, Q_{sol}, during one hour (in J).

2. Calculate the energy used for vaporization, Q_{vap}.

3. Neglecting all losses except those involved in vaporization, calculate the minimum efficiency $\eta = Q_{vap} / Q_{sol}$.

4. In reality, if the total losses (of all types) remove 60% of the solar energy (i.e., only 40% is effectively used for evaporating water), what would be the actual overall efficiency?

Exercise 4 :

A flat-plate solar still was tested on a sunny day in June. The measurements recorded between 10:00 a.m. and 11:00 a.m. are as follows:

- Average incident solar radiation on the still surface: $G=850\ W/m^2$
- Effective collecting area: $A=1.8\ m^2$
- Mass of distilled water collected during this hour: $m=0.72\ kg$
- Average latent heat of vaporization of water: $hfg=2.26\times10^6\ J/kg$

Tasks:

1. Determine the useful energy produced by the still during this hour.
2. Calculate the incident solar energy over the same period.
3. Deduce the Hourly Performance Factor (HPF) of the solar still, defined as:

   $HPF=m\times hfg/G\times A\times\Delta t$. Where Δt is the duration in seconds (here, 1 hour).
4. Physically interpret the result obtained.

Exercise 5 :

Two identical solar stills were tested on the same day. Each still has a collecting area of A=1.00 m2A = 1.00\ \mathrm{m}^2A=1.00 m2. The measured data are:

- Still A: daily mass of distilled water MA=3.60 kg.
- Still B: daily mass of distilled water MB=5.00 kg.
- Daily global irradiation on the surface: H=5.0 $kWh{\cdot}m^{-2}$.
- Adopted latent heat of vaporization: Lv=2.26×10 $J{\cdot}kg^{-1}$.

Tasks:

1. Calculate the total incident solar energy on each still during the day (in joules).
2. Calculate the energy required to vaporize the water produced by each still (in joules).
3. Calculate the Gross Performance Factor (GPF) for each still, defined by

   GPF=M×Lv/ Esol

   where Esol is the incident solar energy (J).
4. Conclude which of the two stills is more efficient and propose two practical reasons that could explain the performance difference.