Virtual and Intensive Course
Developing Practical Skills
of Future Engineers

VIPSKILLS

Erasmus+ 2016-1-PL01-KA203-026152

PROJECT TITLE	**EXAMPLES OF TESTS TO E-LABORATORIES:**
OBJECT	E-LABORATORIES
STUDENT'S NAME AND SURNAME	
DATE	2019

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TESTS TO E-LABORATORY 1

- MODELLING OF A SOLAR COLLECTOR OPERATING

General assumptions:
COLLECTOR OPTICAL EFFICIENCY – 0,7
HEAT LOSS COEFFICIENT – -2 $W/m^2/K$
HEAT LOSS COEFF. (TEMP. DEPEND.) – 0 $W/m^2/K^2$
AREA OF A SINGLE COLLECTOR – 2.5 W/m^2
MASS FLOW RATE – 30 $kg/h/m^2$
INLET FLUID TEMPERATURE – 50 ^oC
EXTERNAL TEMPERATURE – 30 ^oC
Questions:
1. How much will the power output of the solar collector [W] increase with increasing solar radiation intensity from 200 W/m^2 to 500 W/m^2?
=775-250 W
2. How much will the power output of the solar collector [W] increase with increasing solar radiation intensity from 200 W/m^2 to 700 W/m^2?
=1125-250 W
3. How much will the power output of the solar collector [W] increase with increasing solar radiation intensity from 200 W/m^2 to 1000 W/m^2?
=1650-250 W
4. Calculate how much the power output of the solar collector [W] decreases at G = 800 W/m^2 when we change the outside temperature from 30 ^oC to 20 ^oC.
50 W
5. Calculate how much the power output of the solar collector [W] decreases at G = 800 W/m^2 when we change the outside temperature from 30 ^oC to 10 ^oC.
100 W
6. Calculate how much the power output of the solar collector [W] decreases at G = 800 W/m^2 when we change the outside temperature from 30 ^oC to 0 ^oC.
150 W
7. Calculate how much the power output of the solar collector [W] increases at G = 1000 W/m^2 when we change the inlet fluid temperature from 50 ^oC to 40 ^oC.
50 W
8. Calculate how much the power output of the solar collector [W] increases at G = 1000 W/m^2 when we change the inlet fluid temperature from 50 ^oC to 30 ^oC.
=100 W
9. Calculate how much the power output of the solar collector [W] increases at G = 1000 W/m^2 when we change the inlet fluid temperature from 50 ^oC to 20 ^oC.
=150 W
10. Do drop in the mass flow rate will increase outlet temperature of the fluid?
Yes
11. Do drop in the collector optical efficiency will increase outlet temperature of the fluid?
No
12. Does drop in the inlet fluid temperature will increase the collector optical efficiency?
Yes

TESTS TO E-LABORATORY 2

– ESTIMATION OF ENERGY GAINS FROM SOLAR COLLECTORS

1.- Calculate the difference between max and min efficiency of solar 1 collector 2 m2, depending on its inclination angle in Bialystok, Cordoba and Kaunas. Give max and min values.
Answer: 6, 8, 7 (%) 44 (Cordoba), 34 (Bialystok and Kaunas)
2.- For which inclination angles we can obtain max value of efficiency in Cordoba.
Answer: 45, 50
3.- Calculate the difference between total solar radiation in Cordoba and Bialystok for the solar collector sloping 35o.
Answer: 1014 (1989-975)
4.- Calculate the total solar energy from 1,2,3 and 4 collectors (3m2), sloping 35o in Kaunas.
Answer: 1367, 2734, 4102, 5469
5. Is an efficiency of solar collector dependent on a sloping angle?
Answer: yes
6. In case of which inclination angles of we obtain min value in Bialystok?
Answer: 90
7. Calculate the difference between beam solar radiation in Cordoba and Bialystok for the solar collector sloping 35o.
Answer: 1031
8.- Calculate the total solar energy from 1,2,3 and 4 collectors (2m2), sloping 35o in Bialystok.
Answer: 785, 1571, 2356, 3142
9. For which inclination angle the diffuse radiation is the highest in Bialystok, Kaunas and Cordoba?
Answer: 15, 15, 30
9. For which inclination angle the diffuse radiation is the highest in Bialystok, Kaunas and Cordoba?
Answer: 15, 15, 30
10. Calculate a difference between energy gains from 4 collectors (2m2, angle 30°) in Białystok and Warsaw.
Answer: 35 (3928-3893kWh)

TESTS TO E-LABORATORY 3

– ESTIMATION OF HEAT OUTPUT OF STEEL PANEL RADIATOR

1.- Calculate Heat output and logarithm difference of temperatures of a Panel Radiator type C11 with characteristics L=900 H= 500 Q=781W when supply water temperature is 80ºC, exit water temperature is 70ºC and room temperature 21ºC. Give values (without units).
Answer: 864.2 (W), 33.85 (ºC)
2.- Compare the results with a room temperature equal to 13ºC
Answer: 1036.1 (W), 61.87(ºC)
3.- What happen with the Heat output of Panel Radiator when the exit water temperature is lower?... a) Increase b) decrease c) maintain constant
Answer: b) decrease
4.- What happen with the logarithm difference of temperatures of Panel Radiator when the exit water temperature is lower?... a) Increase b) decrease c) maintain constant
Answer: b) decrease
5.- Calculate Heat output and logarithm difference of temperature of panel Radiator of problem 1 when the supply water temperature is 70ºC and drop water temperature and room temperature are the same.
Answer: 469.4 (W), 33.75 (ºC)
6. Calculate Heat output and logarithm difference of temperatures of 10 Panel Radiators type C11 with characteristics L=500 H= 500 Q=434 W when supply water temperature is 70ºC, outlet water temperature is 57ºC and room temperature 18ºC.
Answer: 3918 (W), 45.19 (ºC)
7. Compare the results with a room temperature equal to 22ºC
Answer: 3380 (W), 41.16 (ºC)
8.- What happen with the Heat output of Panel Radiator when the supply water temperature is higher?. Increase, decrease or maintain constant?
Answer: Increase
9.- What happen with the logarithm difference of temperatures of Panel Radiator when the supply water temperature is higher? Increase, decrease or maintain constant?
Answer: Increase
10. - Calculate Heat output and logarithm difference of temperature of panel Radiators of problem 1 when drop water temperature is increased to 25ºC and supply water temperature is 80ºC and room temperature are the same.
Answer: 3060 (W), 38.14 (ºC)

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TESTS TO E-LABORATORY 4

- **DETERMINATION OF THE HEAT OUTPUT OF AN UNDERFLOOR HEATING SYSTEM**

General assumptions regarding underfloor heating:
SUPPLY TEMPERATURE – 45 ^{o}C
TEMPERATURE DROP – 5 ^{o}C
TEMPERATURES BELOW FLOOR – 20 ^{o}C
THICKNESS OF SCREED COVERING ABOVE PIPES – 5 cm
PIPE SPACING – 20 cm
FLOOR COVERING – TERRACOTTA
AREA OF UNDERFLOOR HEATER – 15 m
UPWARDS PARTIAL HEAT TRANSMISSION RESISTANCE OF FLOOR STRUCTURE - 1,5 m^2K/W

Questions:
1. Calculate the total thermal output of the floor heater in the sitting room for the pipe diameter 14×2.
1138 W
2. Calculate the total thermal output of the floor heater in the sitting room for the pipe diameter 16×2.
1160 W
3. Calculate the total thermal output of the floor heater in the sitting room for the pipe diameter 18×2.
1184 W
4. Calculate the total thermal output of the floor heater in the bathroom for the pipe diameter 14×2.
934 W
5. Calculate the total thermal output of the floor heater in the bathroom for the pipe diameter 16×2.
952 W
6. Calculate the total thermal output of the floor heater in the bathroom for the pipe diameter 18×2.
971 W
7. Calculate how much the total thermal output of the floor heater in the bathroom will change for pipe diameter 14×2 when we change the pipe spacing from 10 cm to 15 cm.
140 W
8. Calculate how much the total thermal output of the floor heater in the bathroom will change for pipe diameter 14×2 when we change the pipe spacing from 10 cm to 20 cm.
262 W
9. Calculate how much the total thermal output of the floor heater in the bathroom will change for pipe diameter 14×2 when we change the pipe spacing from 10 cm to 30 cm.
460 W
10. Calculate how much the total thermal output of the floor heater in the living room will change for pipe diameter 16×2 when we change the pipe spacing from 10 cm to 15 cm.
169 W

11. Calculate how much the total thermal output of the floor heater in the living room will change for pipe diameter 16×2 when we change the pipe spacing from 10 cm to 20 cm.
316 W
12. Calculate how much the total thermal output of the floor heater in the living room will change for pipe diameter 16×2 when we change the pipe spacing from 10 cm to 30 cm.
557 W
13. Does the rise in the drop in the fluid temperature cause an increase in the thermal output of the floor heater?
No
14. Does the rise in the thickness of screed covering above pipes cause an increase in the thermal output of the floor heater?
No

TESTS TO E-LABORATORY 5

- **CALCULATION OF THE HEAT LOSS FROM CENTRAL HEATING PIPES AND OUTLET TEMPERATURE OF THE FLUID**

General assumptions:
LENGTH OF THE PIPE – 10m
PIPE DIAMETER – 12×1.
FLUID MASS FLOW RATE - 20 kg/h
INSULATION THICKNESS – 2 cm
TEMPERATURE INSIDE THE PIPE – 65 ^{o}C
AMBIENT TEMPERATURE – 0 ^{o}C

Questions:
1. How much total heat loss of pipes decreases as we increase by 1 cm the thickness of the insulation with a insulation thermal conductivity 0,025 W/m/K (polyurethane foam).
10,7 W
2. How much total heat loss of pipes decreases as we increase by 2 cm the thickness of the insulation with a insulation thermal conductivity 0,025 W/m/K (polyurethane foam).
16,8 W
3. How much total heat loss of pipes decreases as we increase by 5 cm the thickness of the insulation with a insulation thermal conductivity 0,025 W/m/K (polyurethane foam).
25,8 W
4. How much total heat loss of pipes decreases as we increase by 1 cm the thickness of the insulation with a insulation thermal conductivity 0,045 W/m/K (mineral wool).
17 W
5. How much total heat loss of pipes decreases as we increase by 2 cm the thickness of the insulation with a insulation thermal conductivity 0,045 W/m/K (mineral wool).
26,9 W
6. How much total heat loss of pipes decreases as we increase by 5 cm the thickness of the insulation with a insulation thermal conductivity 0,045 W/m/K (mineral wool).
42,1 W
7. Does rising fluid mass flow rate cause drop of the outlet temperature of the fluid?
No

8. Does rising temperature inside the pipe causes drop of the pipe heat loss per unit length?
No
9. Does the decrease in the coefficient of insulation thermal conductivity of the insulation causes increase of the change in temperature of the fluid?
No
10. Does the increase in the length of the pipe causes increase of the change in temperature of the fluid?
Yes

TESTS TO E-LABORATORY 6

- **CALCULATION OF THE INDOOR CARBON DIOXIDE CONCENTRATION**

General assumptions:
CLASSROOM
VOLUME 350 m^3
PARTLY OCCUPANCY: 30 STUDENTS
INDOOR TEMPERATURE 24ºC,
INDOOR PRESSURE 1000 Pa,
ACH = 1.5 h^{-1}
INITIAL CO_2 CONCENTRATION 500 ppm
OUTDOOR CLIMATE CONDITIONS: PRESURE: 1012 Pa, TEMPERATURE 12,4ºC and CO_2 CONCENTRATION 390 ppm

1.- Calculate the indoor CO2 concentration for 25 minutes, 60 minutes and 120 minutes with students in passive activity (CO2 production per person = 35 g/h).
Answer: 957, 1157, 1296
2.- Calculate the indoor CO2 concentration after 120 minutes with students in high activity (CO2 production per person = 55 g/h).
Answer: 1775
4.- The full occupancy capacity of this classroom is 60 students. Find the concentration of CO2 for LOW and HIGH activity 60 minutes.
Answer: 1827 and 2593