James Bird

Laboratory experiment FMET5 –Steam Engine Test

Results:

Test 1:

Quantity	Symbol	Unit	Measurement
Pressure	P	$kN.m^{-2}$	100
Average Engine Speed	N	rpm	722
Torque	T	Nm	0.20
Thermal Power in	$\dot{Q}_{in}$	kW	3.202739
Coolant Temp In T_3	T_3	$°C$	10.60
Coolant Temp Out T_4	T_4	$°C$	18.10
Coolant Temp Difference = Out-In	Θ_{diff}	$°C$	7.5
Coolant volumentric flow rate		$L.min^{-1}$	2.50
Coolant mass flow rate	$\dot{m}$	$kg.s^{-1}$	0.041666667
Condensate flow rate		$L.min^{-1}$	0.071

Quantity	Calculation	Units	Calculated Value
Thermal Power out	$\dot{Q}_{out} = \dot{m}C_p\Theta_{diff}$	kW	1.30625001
Work out	$\dot{W}_{out}$	W	15.12157
Efficiency	$= \frac{\dot{W}_{out}}{\dot{Q}_{in}}$	%	0.47
Heat lost	$\dot{Q}_{in} - \dot{Q}_{out} - \dot{W}_{out}$	W	1881.367

Test 2:

Quantity	Symbol	Unit	Measurement
Pressure	P	$kN.m^{-2}$	180
Average Engine Speed (from Table below)	N	rpm	1134
Torque	T	Nm	0.32
Thermal Power in	$\dot{Q}_{in}$	kW	3.402415
Coolant Temp In T_3	T_3	$°C$	16.60
Coolant Temp Out T_4	T_4	$°C$	30.60
Coolant Temp Difference = Out-In	Θ_{diff}	$°C$	14
Coolant volumentric flow rate		$L.min^{-1}$	2.50
Coolant mass flow rate	$\dot{m}$	$kg.s^{-1}$	0.041666667
Condensate flow rate		$L.min^{-1}$	0.075

Quantity	Calculation	Units	Calculated Value
Thermal Power out	$\dot{Q}_{out} = \dot{m}C_p\Theta_{diff}$	kW	2.438333
Work out	$\dot{W}_{out}$	W	38
Efficiency	$= \frac{\dot{W}_{out}}{\dot{Q}_{in}}$	%	1.12
Heat lost	$\dot{Q}_{in} - \dot{Q}_{out} - \dot{W}_{out}$	W	926.082

Test 3:

Quantity	Symbol	Unit	Measurement
Pressure	P	$kN.m^{-2}$	250
Average Engine Speed (from Table below)	N	rpm	798
Torque	T	Nm	0.56
Thermal Power in	$\dot{Q}_{in}$	kW	3.232985
Coolant Temp In T_3	T_3	$°C$	10.40
Coolant Temp Out T_4	T_4	$°C$	26.20
Coolant Temp Difference = Out-In	Θ_{diff}	$°C$	15.8
Coolant volumentric flow rate		$L.min^{-1}$	2.50
Coolant mass flow rate	$\dot{m}$	$kg.s^{-1}$	0.041666667
Condensate flow rate		$L.min^{-1}$	0.071

Quantity	Calculation	Units	Calculated Value
Thermal Power out	$\dot{Q}_{out} = \dot{m}C_p\Theta_{diff}$	kW	2.751833
Work out	$\dot{W}_{out}$	W	46.79727
Efficiency	$= \frac{\dot{W}_{out}}{\dot{Q}_{in}}$	%	1.45
Heat lost	$\dot{Q}_{in} - \dot{Q}_{out} - \dot{W}_{out}$	W	434.35

Discussion:

In experiment one, we saw a lower efficiency in the equipment compared to the later tests, this could be due to an error whilst reading the data or possibly during the first test the temperature change is far lower meaning some of the energy was wasted initially heating up the equipment or even lost as wasted energy. In test two and three, the equipment was already heated from the previous experiment meaning it needed less energy to fulfil the test.

A way to ensure a more accurate test next time, the students can make sure the energy to heat the water is lower.