Australian Government

MARL019 Apply advanced principles of marine engineering thermodynamics

Release: 1

MARL019 Apply advanced principles of marine engineering thermodynamics

Modification History

Release 1. New unit of competency.

Application

This unit involves the skills and knowledge required to apply advanced principles of marine engineering thermodynamics to perform calculations and to explain the operation of marine machinery, including internal combustion and gas turbine engines, air compressors, steam condensers and refrigeration units.

This unit applies to the work of a Marine Engineer Class 1 on commercial vessels of unlimited propulsion power and forms part of the requirements for the Certificate of Competency Marine Engineer Class 1 issued by the Australian Maritime Safety Authority (AMSA).

No licensing, legislative or certification requirements apply to this unit at the time of publication.

Pre-requisite Unit

Not applicable.

Competency Field

L – Marine Engineering

Unit Sector

Not applicable.

Elements and Performance Criteria

Elements describe the essential outcomes.	Performance criteria describe the performance needed to demonstrate achievement of the element.
1 Calculate heat energy with and without phase change	1.1 Enthalpy is applied to heat mixture calculations with or without phase change
	1.2 Enthalpy is applied to calculate resultant conditions of hot wells involving multiple returns
	1.3 Steam conditions in a system when using throttling devices and separators are calculated

		1.4	Entropy is distinguished from enthalpy
		1.5	Entropy values are determined from standard tables
2	**Analyse change of phase and state diagrams**	2.1	Tables and/or diagrams are used to find enthalpy and entropy values for liquid, part liquid-part vapour and vapour states
		2.2	Carnot cycle is outlined
		2.3	Rankine cycle is outlined
		2.4	Isentropic efficiency is explained
		2.5	Problems are solved involving the efficiency of steam turbines operating in the Rankine cycle
3	**Apply Dalton's law of partial pressures to steam condensers**	3.1	Dalton's Law is applied to calculate air and condensate extraction from condensers
		3.2	Problems are solved involving cooling water mass flow and cooling water pump work
4	**Apply chemical equations for complete and incomplete combustion**	4.1	Atomic and molecular weights and kilogram-mol are explained
		4.2	Calorific value of a fuel is calculated by chemical formula
		4.3	Mass of air required for stoichiometric combustion is calculated by gravimetric and volumetric analysis
		4.4	Air fuel ratio is determined when supplied with composition of fuel and exhaust gas analysis
5	**Apply gas laws to analyse internal combustion engine efficiencies**	5.1	Universal gas constant form AVOGADRO S hypothesis is determined
		5.2	Heat transfer is calculated for constant volume and constant pressure processes
		5.3	First law of thermodynamics is applied to thermodynamic processes in a closed system
		5.4	Second law of thermodynamics is applied to find thermal efficiency of Carnot cycle
		5.5	Mathematical formula is applied to solve problems related to ideal constant volume air standard cycle
		5.6	Mathematical formula is applied to solve problems related to diesel and dual cycles

6	**Calculate performance of internal combustion and gas turbine engines**	6.1	P/V and out of phase engine indicator diagrams are analysed
		6.2	Work, power, mean effective pressure and thermal efficiency of internal combustion engine cycles is calculated
		6.3	Heat transfer to jacket cooling systems is calculated
		6.4	Open and closed systems for gas turbines are outlined
		6.5	Temperature/entropy diagrams are applied to illustrate gas turbine cycles
		6.6	Power, isentropic efficiencies, thermal efficiency, work and fuel consumption for gas turbine cycles is calculated
		6.7	Methods to increase efficiency of gas turbines are specified
		6.8	Reheaters and intercoolers and how they improve efficiency is explained
7	**Analyse air compressor performance**	7.1	Compressor types are classified
		7.2	Volumetric efficiency at free air conditions is explained
		7.3	Work is calculated for isothermal and adiabatic compression, and effect of clearance for reciprocating compressor
		7.4	Pressure ratio for compressor types is analysed
		7.5	Problems are solved relating to multi-staging and intercooling
		7.6	Heat transfer to air or cooling water from an air compressor is calculated
		7.7	Formula to calculate work and efficiency of centrifugal compressors is derived
8	**Analyse vapour compression refrigeration cycles**	8.1	Design parameters for a vapour compression cycle are explained
		8.2	Pressure/enthalpy diagram is prepared for a refrigeration cycle
		8.3	Heat rejected, work done and coefficient of performance (COP) for a basic cycle is calculated
		8.4	Effect of sub cooling and superheating is shown on a temperature/entropy diagram

	8.5	COP is calculated with evaporators operating at two different pressures
9 Apply psychrometric principles to solve air conditioning problems	9.1	Comfort conditions for air conditioning systems are defined
	9.2	Key parameters used in defining air condition are illustrated on a psychrometric chart
	9.3	Cooling loads are calculated
	9.4	Problems associated with air delivering and distribution methods are analysed
	9.5	Methods of controlling noise and vibration in air conditioning systems are analysed
10 Analyse different methods of heat transfer	10.1	Heat flow through composite divisions is calculated
	10.2	Insulation dimensions and interface temperatures are determined
	10.3	Problems relating to radiated energy are solved by applying Stefan-Boltzmann Law
	10.4	Problems in heat exchangers are solved by applying log mean temperature difference
	10.5	Relative efficiency of contra-flow heat exchange is determined

Foundation Skills

Foundation skills essential to performance are explicit in the performance criteria of this unit of competency.

Range of Conditions

Range is restricted to essential operating conditions and any other variables essential to the work environment.

Tables and/or diagrams include one or more of the following:	• pressure–enthalpy • pressure–specific volume • specific enthalpy–specific entropy • temperature–pressure

	• temperature–specific enthalpy • temperature–specific entropy
Thermodynamic processes include one or more of the following:	• adiabatic • isobaric • isochoric • isothermal • polytropic
Parameters include one or more of the following:	• adiabatic saturation or constant enthalpy • humidifying or dehumidifying • latent heat • sensible heat
Methods include one or more of the following:	• duct attenuators • duct lining • lined duct splitters • lined plenums • natural attenuation • sound absorbing materials/placement • vibration isolators • white noise

Unit Mapping Information

This unit replaces and is equivalent to MARL6006A Apply advanced principles of marine engineering thermodynamics.

Links

Companion Volume implementation guides are found in VETNet - https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2