

1-25  A 2 mm thick by 3 cm wide AISI 1010 carbon steel strip is cooled in a chamber from 597 to 47°C to avoid instantaneous thermal burn upon contact with skin tissue. The amount of heat rate to be removed from the steel strip is to be determined.



Assumptions 1 Steady operating conditions exist. 2 The stainless steel sheet has constant specific heat and density. 3 Changes in potential and kinetic energy are negligible.

Properties For AISI 1010 carbon steel, the specific heat of AISI 1010 steel at $(597 + 47)^\circ\text{C} / 2 = 322^\circ\text{C} = 595\text{ K}$ is $682\text{ J/kg}\cdot\text{K}$ (by interpolation from Table A-3), and the density is given as 7832 kg/m^3 .

Analysis The mass of the steel strip being conveyed enters and exits the chamber at a rate of

$$\dot{m} = \rho \dot{V} = \rho b v t$$

The rate of heat being removed from the steel strip in the chamber is given as

$$\begin{aligned}\dot{Q}_{\text{removed}} &= \dot{m} c_p (T_{\text{in}} - T_{\text{out}}) \\ &= \rho b v t c_p (T_{\text{in}} - T_{\text{out}}) \\ &= (7832\text{ kg/m}^3)(1\text{ m/s})(0.030\text{ m})(0.002\text{ m})(682\text{ J/kg}\cdot\text{K})(597 - 47)\text{ K} \\ &= \mathbf{176\text{ kW}}\end{aligned}$$

Discussion By slowing down the conveyance speed of the steel strip would reduce the amount of heat rate needed to be removed from the steel strip in the cooling chamber. Since slowing the conveyance speed allows more time for the steel strip to cool.

Solution Manual Heat Mass Transfer 4

J Dewey



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Analytical Solution Methods for Boundary Value Problems A.S. Yakimov, 2016-08-13 Analytical Solution Methods for Boundary Value Problems is an extensively revised new English language edition of the original 2011 Russian language work which provides deep analysis methods and exact solutions for mathematical physicists seeking to model germane linear and nonlinear boundary problems Current analytical solutions of equations within mathematical physics fail completely to meet boundary conditions of the second and third kind and are wholly obtained by the defunct theory of series These solutions are also obtained for linear partial differential equations of the second order They do not apply to solutions of partial differential equations of the first order and they are incapable of solving nonlinear boundary value problems Analytical Solution Methods for Boundary Value Problems attempts to resolve this issue using quasi linearization methods operational calculus and spatial variable splitting to identify the exact and approximate analytical solutions of three dimensional non linear partial differential equations of the first and second order The work does so uniquely using all analytical formulas for solving equations of mathematical physics without using the theory of series Within this work pertinent solutions of linear and nonlinear boundary problems are stated On the basis of quasi linearization operational calculation and splitting on spatial variables the exact and approached analytical solutions of the equations are obtained in private derivatives of the first and second order Conditions of unequivocal resolvability of a nonlinear boundary problem are found and the estimation of speed of convergence of iterative process is given On an example of trial functions results of comparison of the analytical solution are given which have been obtained on suggested mathematical technology with the exact solution of boundary problems and with the numerical solutions on well known methods Discusses the theory and analytical methods for many differential equations appropriate for applied and computational mechanics researchers Addresses pertinent boundary problems in mathematical physics achieved without using the theory of series Includes results that can be used to address nonlinear equations in heat conductivity for the solution of conjugate heat transfer problems and the equations of telegraph and nonlinear transport equation Covers select method solutions for applied mathematicians interested in transport equations methods and thermal protection studies Features extensive revisions from the Russian original with 115 new pages of new textual content *ERDA Energy Research Abstracts*, 1983 **Scientific and Technical Aerospace Reports**, 1991 Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database **Introduction to Thermal and Fluids Engineering** Deborah A. Kaminski, Michael K. Jensen, 2017-02-14 Kaminski Jensen is the first text to bring together thermodynamics fluid mechanics and heat transfer in an integrated manner giving students the fullest possible understanding of their interconnectedness The three topics are introduced early in the text allowing for applications across these areas early in the course Class tested for two years to more than 800 students at

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