THERMODYNAMICS, ABRIDGED: BASED ON "APPLIED THERMODYNAMICS FOR ENGINEERS" BY THE SAME AUTHOR

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649720217

Thermodynamics, Abridged: Based On "Applied Thermodynamics for Engineers" by the Same Author by William D. Ennis

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

WILLIAM D. ENNIS

THERMODYNAMICS, ABRIDGED: BASED ON "APPLIED THERMODYNAMICS FOR ENGINEERS" BY THE SAME AUTHOR

Trieste

THERMODYNAMICS, ABRIDGED

BASED ON "APPLIED THERMODYNAMICS FOR ENGINEERS" BY THE SAME AUTHOR

BY

WILLIAM D. ENNIS, M.E.

MEM. AM. SOC. M.E., FELLOW A. A. A. S., CONSULTING ENGINEER; VICE PRESIDENT OF THE TECHNICAL ADVISORY CORPORATION OF NEW YORK; FORMERLY PROFESSOR OF MECHANICAL AND MARINE ENGINEERING IN THE POST GRADUATE DEPARTMENT OF THE UNITED STATES NAVAL ACADEMY

SECOND EDITION—CORRECTED

73 ILLUSTRATIONS

NEW YORK

D. VAN NOSTRAND COMPANY

EIGHT WARREN STREET

1922

PRINTED IN THE UNITED STATES OF AMERICA

PREFACE

(WHICH STUDENTS SHOULD READ)

This brief statement of fundamental principles has been prepared especially for the use of midshipmen in the United States Naval Academy. The work was undertaken at the request of Commander J. O. Richardson, U. S. N., Head of the Department of Marine Engineering and Naval Construction, and has been carried on in close coöperation with officers of that Department, particularly Comdr. W. L. Friedell, U. S. N., Lt. Comdr. T. W. Johnson, Professor of Mathematics, U. S. N., and Lt. Comdr. H. W. Boynton, U. S. N.

Thermodynamics is difficult, but worth while. To some extent, it has been simplified by planning the problems for easy solution. The table preceding Chapter II will be found useful for exponential expressions. The solution of many problems is necessary in order that a real grasp of the subject may be attained. All problems should be solved with the slide rule. This implies that answers will be absolutely reliable only with respect to two significant figures, the third figure being estimated. An error which may be as high as 1 per cent. is therefore allowable. The answers given have been obtained by slide rule, and are subject to this error. Other errors may occasionally be found during a first year's use of the book. The student's answer MAY be right, therefore, even when it disagrees with the answer in the book.

One per cent. accuracy is good enough for almost all practical engineering calculations. We rarely know the strength of a material with any greater exactness. Even the dimensions of structural parts are subject to a comparable error. Good engineering is largely a matter of NOT straining at gnats and swallowing camels.

If there is a "royal road" to any kind of learning, thermodynamics will be found to be the royal road to real comprehension of steam machinery.

NUMERICAL CONSTANTS AND COMMONER SYMBOLS

1.34 hp. = 1 kw.	746 watts = 1 hp.
2.3026 = $\log_e x + \log_{10} x$.	778 ft. lb. = 1 B.t.u.
5.403 = 778 ÷ 144.	1544 = $PVm \div wT$, Art. 12.
32.17 = acceleration of gravity.	2545 B.t.u. per hr. = 1 hp.
42.42 B.t.u. per min. = 1 hp.	33 000 ft. lb. per min. = 1 hp.

1 980 000 ft. lb. per hr. = 1 hp.

B.t.u. = British thermal unit(s): Art. 3.
c = clearance: Arts. 7, 39.
C = compression ratio: Arts. 38, 149.
D = displacement: cu. ft: Arts. 7, 42.
e = efficiency: Arts. 34, 80.
= base of Napierian system of logarithms.
e_v = volumetric efficiency: Art. 42.
$E = T + I$ = internal energy of vapor: Art. 63.
F. = Fahrenheit.
F = factor of evaporation: Art. 73.
f = diagram factor: Art. 104.
g = 32.17 = acceleration of gravity.
h = heat of 1 lb. of boiling liquid: Art. 63.
H = total heat of 1 lb. of dry vapor: Art. 65.
H' = total heat of 1 lb. of superheated vapor: Art. 83.
$\boldsymbol{H}$, H = heat received by a substance: Art. 2.
ΣH = net amount of heat received or rejected in a cycle: Art. 21.
hp. = horse power.
ihp., Ihp. = indicated horse power.
I = disgregation work: Art. 2.
I_e = ice melting effect per ihp.-hr.: Art. 59.
kw. = kilowatt(s).
k = specific heat at constant pressure: Art. 14.
l = specific heat at constant volume: Art. 14.
L = stroke of an engine, ft.: Art. 7.
= latent heat of vaporization: Art. 64.
log = logarithm to the base 10.
$\log_e$ = logarithm to the base e = 2.3026 log.
m = molecular weight: Art. 12.
n = polytropic exponent: Art. 24.

n = entropy or change of entropy: Art. 68.
n_w = entropy of 1 lb. of liquid: Art. 71.
n_e = entropy of vaporization: Art. 71.
n_s = total entropy of dry vapor: Art. 71.
n' = total entropy of superheated vapor: Art. 83.
N = r.p.m.: Art. 7.
p = absolute pressure, lb. per sq. in. (= gauge pressure + 14.696).
P = absolute pressure, lb. per sq. ft. = 144 p.
p_m = mean effective pressure: Arts. 7, 39.
p_s = intercooler pressure: Art. 45.
Q = the quantity of heat in 1 lb. of a vapor: Art. 87.
$R = PV + wT$: Art. 12.
r = internal latent heat of vaporization: Art. 65.
= ratio of expansion: Arts. 106, 162.
r.p.m. = revolutions per minute.
s = specific heat: Arts. 3, 27.
t = temperature Fahrenheit.
$T = t + 460$ = absolute temperature: Art. 11.
T = temperature effect of heat: Art. 2.
t' = temperature of superheated vapor: Art. 83.
u, U = velocity, ft. per sec.: Arts. 56, 133.
v = volume of 1 lb. of a substance.
v' = volume of 1 lb. of a superheated vapor: Art. 83.
v_w = volume of 1 lb. of liquid: Art. 65.
V = volume of w lb. of a substance.
w = weight, lb.
W, W = external mechanical work done: Arts. 2, 26.
ΣW = net external work done in a cycle: Art. 21.
x = dryness fraction: Art. 74.
$y = k \div l$ = ratio of specific heats (Art. 17): also adiabatic exponent (Art. 28).

CONTENTS