Design Manual for High Temperature Hot Water and Steam Systems

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In tribute to the long-standing patience of my wife and daughters
Elizabeth, Sherry, Tracy, Stacy, and Terry

PREFACE

This book is written with an awareness of the transition period usually required to develop a graduate student of engineering into an economically productive professional. The material presented is intended to help accelerate an engineer's or designer's growth as a well trained practitioner. By this means, the skills and knowledge acquired in college can more promptly be applied to the benefit of industry.

To achieve this task, information has been obtained from the desks of experienced design engineers, from related technical references, and from a variety of product references used in the design and construction of HTW and steam generation plants. This reference is dedicated to the needs of the engineer responsible for immediate design decisions involving equipment design, selections, and plant construction cost estimates. The information presented covers the following points: (1) information needed to generate immediate solutions on a day to day basis and (2) current technical reference materials and manufacturer's product data coordinated to optimize project design time.

In summary, this book is meant to be used as a quick source of technical material for the engineer or designer actively involved in designing high pressure and high temperature energy generation plants.

ROGERS E. COFIELD, JR.

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R.E.C.

Abbreviations

abs.	absolute
acfm	actual cubic feet per minute
act.	actual
AGA	American Gas Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
avg.	average
BFD	boiler feedwater demand
bhp	brake horsepower
Bot.	bottle
btu	British thermal unit
Bun.	bunker
cfm	cubic feet per minute
cfs	cubic feet per second
CHP	Central Heating Plant
comp.	compressor
CTR	coal tonnage requirement
db	dry bulb temperature (°F)
d.c.	mechanical dust collector
DO	ditto
eff.	Efficiency
EPA	Environmental Protection Agency
exch.	Exchanger
F	LTMD correction factor
FD	forced draft
FGD	flue gas desulfurization
fpm	feet per minute
fps	feet per second

ft	foot
ft^2	square foot
ft^3	cubic foot
fw	feedwater
gal	gallons
gen.	generator
gpm	gallons per minute
gr.	grains
gr./lb	grains per pound
HHV	high heating value
hp	Horsepower
HP_B	horsepower to drive the empty belt
HP_L	horsepower to move the load against friction
HP_G	horsepower to overcome gravity due to raising and lowering the load
HP_I	horsepower to overcome inertia in putting material into motion
HP_M	horsepower to keep belt in motion under load
hr	hour
hr/min	hours per minute
ht	heat
HTE	high temperature energy
HTW	high temperature water
HVAC	heating, ventilation, and air conditioning
h_1	tube side heat transfer coefficient
h_0	shell side heat transfer coefficient
h_s	enthalpy of steam (btu/lb)
h_w	enthalpy of water (btu/lb)
icfm	inlet cubic foot per minute
ID	induced draft
I.D.	inside diameter
in.	inches
in. Hg	inches of mercury column
in. w.c.	inches of water column
IPS	iron pipe size
kW	kilowatts
kWhr	kilowatts per hour
lb	pounds
lb/hr	pounds per hour

lb/mol	pound per moles
lb/ton	pounds per ton
LMTD	logarithmic mean temperature difference
$\log_{10}$	common logarithm (base 10)
min	minute
mol	moles
(MS)	multistage
N_2	nitrogen
NFPA	National Fire Protection Association
No.	number
N_{re}	Reynolds number (dimensionless)
O.D.	outside diameter
OPEC	Organization of Petroleum Exporting Countries
OSHA	Occupational Safety and Health Act
ΔP	total pressure
PPDAR	project preliminary design analysis report
ppm	parts per million
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gage
Remun.	remuneration
ROM	run-of-mine
rpm	revolutions per minute
r_f	fouling resistance heat transfer coefficient
r_w	tube wall resistance heat transfer coefficient
(S)	single stage
sat.	saturated steam conditions
scfm	standard cubic foot per minute
sec	second
S.F.	safety factor
sh	superheat
sp. gr.	specific gravity
sp. ht.	specific heat (btu/lb °F)
SSU	Seconds Saybolt Universal
std.	standard
stm	steam
T_1	hot medium (fluid) inlet temperature
T_2	hot medium (fluid) outlet temperature

t_1	cold medium (fluid) inlet temperature
t_2	cold medium (fluid) outlet temperature
ΔT	total temperature
TEMA	Tubular Exchangers Manufacturers Association
ton	long ton
tph	tons per hour
tpw	tons per work week
wb	wet bulb temperature (°F)
w.c.	water column
W.F.	wear safety factor
yr	year

SYMBOLS

π	3.1416
≅	Equivalent
%	Percent
°F	degree fahrenheit
°C	degree celsius
(↑)	gaseous element or compound
μ	micron
$	U.S. dollars

Contents