iemisc: Comparing Saturated Vapor Pressure Formulas to the Reference

Irucka Embry, E.I.T. (EcoC²S)

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Contents

Replicate the R code

Note: If you wish to replicate the R code below, then you will need to copy and paste the following commands in R first (to make sure you have all the packages and their dependencies):

```
install.packages(c("install.load", "iemisc", "units"))
# install the packages and their dependencies
```

```
# load the required packages
install.load::load_package("iemisc", "units", "pander")
# load needed packages using the load_package function from the install.load
# package (it is assumed that you have already installed these packages)

import::from(fpCompare, "%==%")
```

Compare Water Saturation Vapor Pressure

```
install.load::load_package("iemisc", "data.table", "units", "pander")


# reference vapor pressures from the Huang reference
reference <- sort(c(611.655, 2339.32, 7384.94, 19946.4, 47414.5, 101418))

Temp <- sort(c(0.01, seq(from = 20, to = 100, by = 20)))

# hydraulics
hydraulics_svp <- hydraulics::svp(T = Temp, units = "SI")


# iemisc
iemisc_sat_vapor_pressure_huang <- sat_vapor_pressure(Temp = Temp, units = "SI",
    formula = "Huang")

iemisc_sat_vapor_pressure_buck <- sat_vapor_pressure(Temp = Temp, units = "SI", formula = "Buck")

iemisc_sat_vapor_pressure_iapws <- sat_vapor_pressure(Temp = Temp, units = "SI",
    formula = "IAPWS")



# aiRthermo

# create a numeric vector with the units of degrees Celsius
T_C <- set_units(Temp, "degree_C")
T_C

## Units: [°C]
## [1] 1e-02 2e+01 4e+01 6e+01 8e+01 1e+02
# create a numeric vector to convert from degrees Celsius to Kelvin
T_K <- T_C
T_K

## Units: [°C]
## [1] 1e-02 2e+01 4e+01 6e+01 8e+01 1e+02
# create a numeric vector with the units of Kelvin
units(T_K) <- make_units(K)

aiRthermo_saturation_pressure_H2O <- aiRthermo::saturation_pressure_H2O(drop_units(T_K))



comparePress <- data.table(Reference_Pressure = reference, Hydraulics_Pressure = hydraulics_svp,
    Huang_Pressure = iemisc_sat_vapor_pressure_huang, Buck_Pressure = iemisc_sat_vapor_pressure_buck,
    IAPWS_Pressure = iemisc_sat_vapor_pressure_iapws, aiRthermo_Pressure = aiRthermo_saturation_pressur

comparePress[, `:=`(mreHydraulics = mapply(mre, Hydraulics_Pressure, Reference_Pressure) *
    100, mreHuang = mapply(mre, Huang_Pressure, Reference_Pressure) * 100, mreBuck = mapply(mre,
    Buck_Pressure, Reference_Pressure) * 100, mreIAPWS = mapply(mre, IAPWS_Pressure,
    Reference_Pressure) * 100, mreaiRthermo = mapply(mre, aiRthermo_Pressure, Reference_Pressure) *
    100)]  # Source 1
```

```
# which row(s) has the maximum value
max_row <- pmax(comparePress$mreHydraulics, comparePress$mreHuang, comparePress$mreBuck,
    comparePress$mreIAPWS, comparePress$mreaiRthermo)

# which row(s) has the minimum value
min_row <- pmin(comparePress$mreHydraulics, comparePress$mreHuang, comparePress$mreBuck,
    comparePress$mreIAPWS, comparePress$mreaiRthermo)

# which rows are TRUE
max_row2 <- comparePress == max_row


# which rows are TRUE
min_row2 <- comparePress == min_row

comparePress[, max_mre := c(rep("mreaiRthermo", 3), rep("mreBuck", 3))]

comparePress[, min_mre := c("mreBuck", rep("mreHydraulics / mreHuang", 4), "mreIAPWS")]

setnames(comparePress, c("Reference Pressure (Pa)", "Hydraulics Package Pressure (Pa)",
    "Huang Pressure (Pa)", "Buck Pressure (Pa)", "IAPWS Pressure (Pa)", "aiRthermo Pressure (Pa)",
    "MRE % (Hydraulics Package vs. Reference)", "MRE % (Huang vs. Reference)", "MRE % (Buck vs. Referen
    "MRE % (IAPWS vs. Reference)", "MRE % (aiRthermo vs. Reference)", "Maximum MRE % Formula",
    "Minumum MRE % Formula"))

pander(comparePress)
```

Reference Pressure (Pa)	Hydraulics Package Pressure (Pa)	Huang Pressure (Pa)
611.7	611.7	657.1
2339	2339	657.1
7385	7385	657.1
19946	19946	657.1
47414	47415	657.1
101418	101417	657.1

Buck Pressure (Pa)	IAPWS Pressure (Pa)	aiRthermo Pressure (Pa)
611.7	611.7	611.4
2338	2339	2335
7382	7385	7382
19945	19947	19945
47410	47416	47410
101308	101418	101308

MRE % (Hydraulics Package vs. Reference)	MRE % (Huang vs. Reference)
0.005632	7.432
3.205e-05	71.91
9.734e-05	91.1
0.001482	96.71

MRE % (Hydraulics Package vs. Reference)	MRE % (Huang vs. Reference)
0.001141	98.61
0.0009911	99.35

MRE % (Buck vs. Reference)	MRE % (IAPWS vs. Reference)
0.0001454	0.0003384
0.04189	0.005397
0.03494	0.002308
0.006289	0.004926
0.008927	0.002709
0.1087	6.096e-06

MRE % (aiRthermo vs. Reference)	Maximum MRE % Formula	Minumum MRE % Formula
0.03453	mreaiRthermo	mreBuck
0.1765	mreaiRthermo	mreHydraulics / mreHuang
0.03494	mreaiRthermo	mreHydraulics / mreHuang
0.006289	mreBuck	mreHydraulics / mreHuang
0.008927	mreBuck	mreHydraulics / mreHuang
0.1087	mreBuck	mreIAPWS

Works Cited

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Huang, J. (2018). "A Simple Accurate Formula for Calculating Saturation Vapor Pressure of Water and Ice", *Journal of Applied Meteorology and Climatology*, 57(6), 1265-1272. Retrieved Nov 4, 2021, https://journals.ametsoc.org/view/journals/apme/57/6/jamc-d-17-0334.1.xml. Please note that the **Reference** values are obtained from this reference.

Jon Sáenz, Santos J. González-Rojí, Sheila Carreno-Madinabeitia and Gabriel Ibarra-Berastegi, `aiRthermo` version 1.2.1, 2018-09-16, https://CRAN.R-project.org/package=aiRthermo

The International Association for the Properties of Water and Steam. IAPWS SR1-86(1992). "Revised Supplementary Release on Saturation Properties of Ordinary Water Substance", September 1992, http://www.iapws.org/relguide/Supp-sat.pdf

R Source

Source 1
r - How do I reset all options() arguments to their default values? - Stack Overflow answered by stevec on Jul 27 2020 and edited by stevec on Feb 27 2022. See https://stackoverflow.com/questions/36848785/how-do-i-reset-all-options-arguments-to-their-default-values

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