Package 'zFactor'

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Type Package

Title Calculate the Compressibility Factor 'z' for Hydrocarbon Gases

Version 0.1.7

Description Computational algorithms to solve equations and find the compressibility factor `z` of hydrocarbon gases. Correlations available: Hall-Yarborough, Dranchuk-AbuKassem, Dranchuk-Purvis-Robinson, Beggs-Brill, Papp, Shell and an Artificial Neural Network correlation (Ann10) by Kamyab et al. The package uses the original Standing-Katz chart for statistical comparison and plotting. Applicable to sweet hydrocarbon gases for now.

Imports rootSolve, tidyr, ggplot2, data.table, tibble, dplyr

Suggests knitr, rmarkdown, testthat, knitcitations, covr

Depends R (>= 2.10)

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NeedsCompilation no

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R topics documented:

`zFactor-package` *Calculation of compressibility factors using varius correlations*

Description

Calculation of compressibility factors using varius correlations

Details

zFactor.

Author(s)

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convertStringToVector *split a long string to create a vector for testing*

Description

split a long string to create a vector for testing

Usage

```
convertStringToVector(str)
```

Arguments

str	a contnuous long string to split as a vector

Examples

```
convertStringToVector("1.05 1.10 1.20")
# result: "c(1.05, 1.1, 1.2)"
# now, you can paste the vector in your test
```

createTidyFromMatrix *Create a tidy table from Ppr and Tpr vectors*

Description

Create a tidy table from Ppr and Tpr vectors

Usage

```
createTidyFromMatrix(ppr_vector, tpr_vector, correlation)
```

Arguments

ppr_vector	a pseudo-reduced pressure vector
tpr_vector	a pseudo-reduced temperature vector
correlation	a z-factor correlation

Examples

```
ppr <- c(0.5, 1.5, 2.5, 3.5)
tpr <- c(1.05, 1.1, 1.2)
createTidyFromMatrix(ppr, tpr, correlation = "DAK")
createTidyFromMatrix(ppr, tpr, correlation = "BB")
```

DAK.genDataset7p4t *Generate a dataset of z values calculated by DAK*

Description

Generate a dataset of z values calculated by DAK

Usage

```
DAK.genDataset7p4t(to_disk = FALSE)
```

Arguments

to_disk	logical indicator to save Rda file to disk. Default FALSE

dak_short *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
dak_short
```

Format

An object of class `matrix` with 4 rows and 7 columns.

DPR.genDataset7p4t *Generate a dataset of z values calculated by DPR*

Description

Generate a dataset of z values calculated by DPR

Usage

```
DPR.genDataset7p4t(to_disk = FALSE)
```

Arguments

to_disk	logical indicator to save Rda file to disk. Default FALSE

dpr_short — *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
dpr_short
```

Format

An object of class `matrix` with 4 rows and 7 columns.

getStandingKatzCurve — *Read file with readings from Standing-Katz chart, create data file and plot*

Description

Read a .txt file that was created from readings of the Standing-Katz chart, then convert it to a .rda file and plot the curve for given Tpr. If no values are supplied, the function will plot the SK curve at Tpr=1.30, low Ppr.

Usage

```
getStandingKatzCurve(tpr = 1.3, pprRange = "lp", tolerance = 0.01,
  toView = FALSE, toSave = FALSE, toPlot = TRUE, ylim = c(0.2, 1.2))
```

Arguments

tpr	Pseudo-reduced temperature curve in SK chart
pprRange	Takes one of two values: "lp": low pressure, or "hp" for high pressure
tolerance	rounding tolerance to avoid rounding readings that are in the middle of the grid. "tolerance" adds flexibility in deciding point closeness. Default value is 0.01.
toView	set to FALSE to prevent visualizing the dataframe
toSave	set to FALSE to indicate if the .rda file will not be saved to disk
toPlot	set to FALSE to indicate the dataset will not be plotted
ylim	minimum (0.2) and maximum (1.2) limits for the y-scale

Examples

```
# get SK curve for low-pressure chart
getStandingKatzCurve()
# get SK curve for high-pressure chart
getStandingKatzCurve(tpr = 1.3, pprRange = 'hp', toView = FALSE, toSave = FALSE)
```

`getStandingKatzData` *Read a file with readings from Standing-Katz chart. Similar to 'getStandingKatzCurve' function but this gets only the data.*

Description

Read a .txt file that was created from readings of the Standing-Katz chart and retrieve the points

Usage

```
getStandingKatzData(tpr = 1.3, pprRange = "lp")
```

Arguments

tpr	Pseudo-reduced temperature curve in SK chart. Default Tpr=1.30
pprRange	Takes one of two values: "lp": low pressure, or "hp" for high pressure. Default is "lp".

Examples

```
getStandingKatzData(tpr = 1.5, pprRange = 'lp')
# with a vector
#tpr <- c(1.05, 1.1, 1.2)
#getStandingKatzData(tpr, pprRange = 'lp')
```

`getStandingKatzMatrix` *Generate a matrix of Standing-Katz pseudo-reduced pressure and tenperature by giving vector values*

Description

Generate a matrix of Standing-Katz pseudo-reduced pressure and tenperature by giving vector values

Usage

```
getStandingKatzMatrix(ppr_vector = NULL, tpr_vector = NULL,
  pprRange = "lp")
```

Arguments

ppr_vector	a vector of pseudo-reduced pressure
tpr_vector	a vector of pseudo-reduced temperatures
pprRange	Takes one of two values: "lp": low pressure, or "hp" for high pressure. Default: "lp"

Examples

```
# if we want to know all digitized values of Ppr at a Tpr curve
tpr_vec <- c(2.0)
getStandingKatzMatrix(tpr_vector = tpr_vec,
                      pprRange = "lp")
# or to extract at a Ppr=1.5
getStandingKatzMatrix(tpr_vector = tpr_vec, pprRange = "lp")[1, "1.5"]
# for two vectors
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
sk <- getStandingKatzMatrix(ppr_vector = ppr, tpr_vector = tpr)
print(sk)
```

---

getStandingKatzTpr *Get a numeric vector of the digitized curves available for Pseudo Reduced Temperature*

Description

Get a numeric vector of the digitized curves available for Pseudo Reduced Temperature

Usage

```
getStandingKatzTpr(pprRange = NULL)
```

Arguments

pprRange	Takes one of 4 values: "lp": low pressure, or "hp" for high pressure; "all": all curves; "common": only curves that are common to hp and lp

Examples

```
getStandingKatzTpr(pprRange = "lp")
getStandingKatzTpr(pprRange = "common")
```

---

get_z_correlations *Get correlation information*

Description

Get information about the correlation specifying for short name, long name or the name of the function.

Usage

```
get_z_correlations(how = "short")
```

Arguments

how	short: abbreviations; long: description; function: the name of the correlation function

Examples

```
# get the short name for the correlation
get_z_correlations(how = "short")

# get the description for the correlation
get_z_correlations(how = "long")

# get the name of the function assgined to the correlation
get_z_correlations(how = "function")
```

HY.genDataset7p4t *Generate a dataset of z values read from Standing-Kats chart*

Description

Generate a dataset of z values read from Standing-Kats chart

Usage

```
HY.genDataset7p4t(to_disk = FALSE)
```

Arguments

to_disk	logical indicator to save Rda file to disk. Default FALSE

---

hy_short *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
hy_short
```

Format

An object of class `matrix` with 4 rows and 7 columns.

isValid_correlation *Check if supplied correlation (three letter) is valid*

Description

Check if supplied correlation (three letter) is valid

Usage

```
isValid_correlation(correlation)
```

Arguments

correlation	a z-factor correlation

listStandingKatzCurves *List all Standing-Katz curve files available at Low and High pressures*

Description

List all Standing-Katz curve files available at Low and High pressures

Usage

```
listStandingKatzCurves(pprRange = "lp")
```

Arguments

pprRange	Takes one of three values: "lp": low pressure, or "hp" for high pressure, or 'all' for all the curve text files. The text files reside under extdata. High pressure is considered above a Ppr > 8.

Examples

```
listStandingKatzCurves(pprRange = 'all')  # list all curves
listStandingKatzCurves(pprRange = 'lp')   # list all the Tpr for low-pressure
#' listStandingKatzCurves(pprRange = 'hp')   # list all the Tpr for high-pressure
```

multiplotStandingKatz *Plot multiple Tpr isotherm curves in one figure*

Description

Plot shows the digitized isotherm of the Standing-Katz chart

Usage

```
multiplotStandingKatz(tpr = NULL, pprRange = "lp", ...)
```

Arguments

tpr	a vector of one of multiple Pseudo-reduced temperatures
pprRange	Takes one of two values: "lp": low pressure, or "hp". Default: "lp"
...	additional parameters

Examples

```
# plot Standing-Katz curves for Tpr=1.1 and 2.0
multiplotStandingKatz(c(1.1, 2))

# plot SK curves for the lowest range of Tpr
multiplotStandingKatz(c(1.05, 1.1, 1.2))
```

Ppr_min *# Correlation Kamyab et al. Created using Artificial Neural Networks (ANN)*

Description

Correlation Kamyab et al. Created using Artificial Neural Networks (ANN)

Usage

```
Ppr_min
```

Format

An object of class numeric of length 1.

SK.genDataset7p4t *Generate a dataset of z values read from Standing-Kats chart*

Description

Generate a dataset of z values read from Standing-Kats chart

Usage

```
SK.genDataset7p4t(to_disk = FALSE)
```

Arguments

to_disk	logical indicator to save Rda file to disk. Default FALSE

sk_short *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
sk_short
```

Format

An object of class `matrix` with 4 rows and 7 columns.

stats_of_z.stats *Statistics on z.stats table*

Description

This function summarizes the tables generated by z.stats using custom provided functions. We get a shorter table with statistics of statistics.

Usage

```
stats_of_z.stats(stat = "MAPE")
```

Arguments

stat	Any of the statistical variables in z.stats: RMSE, MPRE, MAPE, MSE, RSS, MAE

Examples

```
## Not run:
# Get a statistical summary of the Mean Absolute Percentage Error (MAPE)
stats_of_z.stats()

## End(Not run)
```

---

z.Ann10 *Artificial Neural Network correlation*

Description

Artificial Neural Network correlation

Usage

```
z.Ann10(pres.pr, temp.pr, tolerance, verbose)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	controls the iteration accuracy
verbose	print internal

Examples

```
# calculate a single z point
ppr <- 1.5
tpr <- 2.0
z.calc <- z.Ann10(pres.pr = ppr, temp.pr = tpr)
## calculate z for multiple Ppr and Tpr
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.05, 1.1, 1.7, 2)
z.calc <- z.Ann10(ppr, tpr)
```

z.BeggsBrill *Beggs and Brill correlation*

Description

Calculate the Z factor with the Brill-Beggs correlation

Usage

```
z.BeggsBrill(pres.pr, temp.pr, tolerance = 1e-13, verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	rounding tolerance to avoid rounding readings that are in the middle of the grid. "tolerance" adds flexibility in deciding point closeness.
verbose	print internal

Examples

```
## one single z calculation
z.BeggsBrill(pres.pr = 1.5, temp.pr = 2.0)
## calculate z for multiple values of Tpr and Ppr
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
z.BeggsBrill(pres.pr = ppr, temp.pr = tpr)
```

z.DranchukAbuKassem *Dranchuk-AbouKassem correlation*

Description

Dranchuk-AbouKassem correlation

Usage

```
z.DranchukAbuKassem(pres.pr, temp.pr, tolerance = 1e-13, verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	controls the iteration accuracy
verbose	print internal calclulations

Examples

```
## calculate z for one Tpr curve at a single Ppr
z.DranchukAbuKassem(pres.pr = 1.5, temp.pr = 2.0)
## For vectors of Ppr and Tpr:
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
z.DranchukAbuKassem(pres.pr = ppr, temp.pr = tpr)
## create and print comparison tables with the z matrices
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.05, 1.1, 1.7, 2)
z.calc <- z.DranchukAbuKassem(ppr, tpr)
z.chart <- getStandingKatzMatrix(ppr_vector = ppr, tpr_vector = tpr)
ape <- abs((z.calc - z.chart) / z.chart) * 100
cat("z.correlation \n"); print(z.calc)
cat("\n z.chart \n"); print(z.chart)
cat("\n APE \n"); print(ape)
```

---

z.DranchukPurvisRobinson

Dranchuk-Purvis-Robinson correlation

Description

Dranchuk-Purvis-Robinson correlation

Usage

```
z.DranchukPurvisRobinson(pres.pr, temp.pr, tolerance = 1e-13,
  verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	controls the iteration accuracy
verbose	print internal

Examples

```
## calculate for one Tpr curve at a Ppr
z.DranchukPurvisRobinson(pres.pr = 1.5, temp.pr = 2.0)

## For vectors of Ppr and Tpr:
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
z.DranchukPurvisRobinson(pres.pr = ppr, temp.pr = tpr)

## create a matrix of z values
```

```
tpr2 <- c(1.05, 1.1, 1.2, 1.3)
ppr2 <- c(0.5, 1.0, 1.5, 2, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5)
sk_corr_2 <- createTidyFromMatrix(ppr2, tpr2, correlation = "DPR")
tibble::as.tibble(sk_corr_2)
```

---

z.HallYarborough *Hall-Yarborough correlation*

Description

Hall-Yarborough correlation

Usage

```
z.HallYarborough(pres.pr, temp.pr, tolerance = 1e-13, verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	controls the iteration accuracy
verbose	print internal

Examples

```
# get z value from a Tpr at Ppr
z.HallYarborough(pres.pr = 1.5, temp.pr = 2.0)
z.HallYarborough(pres.pr = 1.5, temp.pr = 1.1)

# for two given Tpr and Ppr vectors, find the calculated z points
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
hy <- z.HallYarborough(pres.pr = ppr, temp.pr = tpr)
print(hy)
```

---

z.Papp *Papp correlation*

Description

Calculate the Z factor with the Papp correlation

Usage

```
z.Papp(pres.pr, temp.pr, tolerance = 1e-13, verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	rounding tolerance to avoid rounding readings that are in the middle of the grid. "tolerance" adds flexibility in deciding point closeness.
verbose	print internal

Examples

```
# Example 1
## one single z calculation
z.Papp(pres.pr = 1.5, temp.pr = 2.0)
# Example 2
## calculate z for multiple values of Tpr and Ppr
ppr <- c(0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5)
tpr <- c(1.3, 1.5, 1.7, 2)
z.Papp(pres.pr = ppr, temp.pr = tpr)
```

---

z.plot.range *Tile plot of best fit area for a correlation*

Description

Plot will show blue areas with the lowest errors and redish with very high error or close to MAPE=25. Pink is much greater than 25.

Usage

```
z.plot.range(correlation = "DAK", stat = "MAPE", pprRange = "lp", ...)
```

Arguments

correlation	identifier. Can be "HY", "DAK", "DPR" "N10", "SH"
stat	Any of the statistical variables in z.stats:
pprRange	low (lp) or high (hp) chart area of the Standing-Katz chart
...	any other parameter

Examples

```
# plot Dranchuk-AbouKassem
z.plot.range("DAK")

# plot Beggs-Brill correlation with fine grid on Ppr
z.plot.range("BB", interval = "fine")
```

z.Shell *Shell correlation from Kumar thesis (2005)*

Description

Shell correlation from Kumar thesis (2005)

Usage

```
z.Shell(pres.pr, temp.pr, tolerance = 1e-13, verbose = FALSE)
```

Arguments

pres.pr	pseudo-reduced pressure
temp.pr	pseudo-reduced temperature
tolerance	controls the iteration accuracy
verbose	print internal

Examples

```
# single z point and create a dataframe with info
ppr <- 1.5
tpr <- 1.1
z.calc <- z.Shell(pres.pr = ppr, temp.pr = tpr)
# From the Standing-Katz chart we obtain a digitized point:
z.chart <- getStandingKatzMatrix(tpr_vector = tpr,
                                 pprRange = "lp")[1, as.character(ppr)]
ape <- abs((z.calc - z.chart) / z.chart) * 100
df <- as.data.frame(list(Ppr = ppr,  z.calc =z.calc, z.chart = z.chart, ape=ape))
rownames(df) <- tpr
df
```

z.stats *Summary statistics table for a correlation*

Description

Get error summary statistics for any given compressibility correlation. A quick way to show an error summary between any of the indicated correlations and the Standing-Katz chart.

MSE: Mean Squared Error RMSE: Root Mean Squared Error RSS: Residual sum of Squares RMSLE: Root Mean Squared Logarithmic Error. Penalizes understimation. MAPE: Mean Absolute Percentage Error = AARE MPE: Mean Percentage error = ARE MAE: Mean Absolute Error

Usage

```
z.stats(correlation = "DAK", pprRange = "lp", interval = "coarse")
```

Arguments

correlation	identifier. Can be "HY", "DAK", "DPR" "N10", "SH"
pprRange	low (lp) or high (hp) chart area of the Standing-Katz chart
interval	quality of the Ppr scale. Coarse: every 1.0; Fine: every 0.5

Examples

```
## Not run:
# error statistics for the Dranchuk-AbouKassem correlation
z.stats("DAK")

## End(Not run)
```

---

z.stats_quantile *Quantiles for z.stats*

Description

Calculate the quantiles for any of the statistical variables that originates from calling z.stats

Usage

```
z.stats_quantile(stat = "MAPE")
```

Arguments

stat	Any of the statistical variables in z.stats: RMSE, MPRE, MAPE, MSE, RSS, MAE

---

z_HY *Hall-Yarborough tidy dataset*

Description

28 observations of 5 variables

Usage

```
z_HY
```

Format

An object of class `data.frame` with 28 rows and 5 columns.

z_hy_deriv *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
z_hy_deriv
```

Format

An object of class `matrix` with 4 rows and 7 columns.

z_sk_chart *Hall-Yarborough tidy dataset*

Description

Hall-Yarborough tidy dataset

Usage

```
z_sk_chart
```

Format

An object of class `matrix` with 4 rows and 7 columns.

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