Package 'Raquifer'

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Type Package

Title Estimate the Water Influx into Hydrocarbon Reservoirs

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Description
Generate a table of cumulative water influx into hydrocarbon reservoirs over time using unsteady and pseudo-
steady state models. Van Everdingen, A. F. and Hurst, W. (1949) <doi:10.2118/949305-G>. Fetkovich, M. J. (1971) <doi:10.2118/2603-PA>. Yildiz, T. and Khosravi, A. (2007) <doi:10.2118/103283-PA>.

License GPL-3

URL https://susaenergy.github.io/Raquifer_ws/

Imports Rdpack, magrittr, dplyr, pracma, gsl

RdMacros Rdpack

Suggests knitr, rmarkdown, testthat, ggplot2

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R topics documented:

`aquifer_param` *A list object for aquifer prameters*

Description

Create an object of class 'aquifer'

Usage

```
aquifer_param(
  input_unit = NULL,
  output_unit = NULL,
  model = NULL,
  flow_type = NULL,
  water_drive = NULL,
  phi = NULL,
  perm_h = NULL,
  perm_v = NULL,
  h_a = NULL,
  r_a = NULL,
  r_R = NULL,
  w_a = NULL,
  l_a = NULL,
  tetha = NULL,
  mu_water = NULL,
  c_water = NULL,
  c_rock = NULL,
  pressure = NULL
)
```

Arguments

input_unit	a unit system for parameters, a character string either 'SI' or 'Field'
output_unit	a unit system for properties, a character string either 'SI' or 'Field'
model	state of flow in the aquifer, a character string either 'uss' for the un-steady state flow or 'pss' for the pseudo-steady state flow
flow_type	a character string either 'radial' or 'linear'
water_drive	a character string either 'edge' or 'bottom'
phi	aquifer porosity, a numeric fraction
perm_h	aquifer horizontal permeability in 'md' in both 'SI' and 'Field' input unit systems. A NULL value must be used for the combination of 'uss', 'linear', and 'bottom' flow
perm_v	aquifer vertical permeability in 'md' in both 'SI' and 'Field' input unit systems. A NULL value must be used for the combination of 'uss', 'linear', 'edge' flow. A NULL value must be used for the combination of 'uss', 'radial', 'edge' flow. A NULL value must be used for the combination of 'pss', 'radial', 'edge' flow.
h_a	aquifer height in 'm' or 'ft' in 'SI' and 'Field' input unit systems, respectively.
r_a	aquifer radius in 'm' or 'ft' in 'SI' and 'Field' input unit systems, respectively. A NULL value must be used for the combination of 'uss', 'linear', 'edge' flow. A NULL value must be used for the combination of 'uss', 'linear', 'bottom' flow.
r_R	reservoir radius in 'm' or 'ft' in 'SI' and 'Field' input unit systems, respectively. A NULL value must be used for the combination of 'uss', 'linear', 'edge' flow. A NULL value must be used for the combination of 'uss', 'linear', 'bottom' flow.
w_a	aquifer width in 'm' or 'ft' in 'SI' and 'Field' input unit systems, respectively. A NULL value must be used for the combination of 'uss', 'radial', 'edge' flow. A NULL value must be used for the combination of 'uss', 'radial', 'bottom' flow. A NULL value must be used for the combination of 'pss', 'radial', 'edge' flow.
l_a	aquifer length in 'm' or 'ft' in 'SI' and 'Field' input unit systems, respectively. A NULL value must be used for the combination of 'uss', 'radial', 'edge' flow. A NULL value must be used for the combination of 'uss', 'radial', 'bottom' flow. A NULL value must be used for the combination of 'pss', 'radial', 'edge' flow.
tetha	fraction of reservoir encircled by the aquifer, reported in "degrees" in both 'SI' and 'Field' input unit systems. A NULL value must be used for the combination of 'uss', 'radial', 'bottom' flow. A NULL value must be used for the combination of 'uss', 'linear', 'edge' flow. A NULL value must be used for the combination of 'uss', 'linear', 'bottom' flow.
mu_water	water viscosity in 'mPa.s' or 'cp' in 'SI' and 'Field' input unit systems, respectively
c_water	water compressibility in '1/kPa' or '1/psi' in 'SI' and 'Field' input unit systems, respectively
c_rock	rock compressibility in '1/kPa' or '1/psi' in 'SI' and 'Field' input unit systems, respectively
pressure	a numeric vector of pressure data at the boundary of reservoir/aquifer. Must have the same length as the 'aquifer_time()' object

Value

a list of class 'aquifer' with all the required parameters for the aquifer_predict() S3 methods

Examples

```
aquifer_param_01 <- aquifer_param(input_unit = "Field", output_unit = "Field",
model = "uss", flow_type = "radial", water_drive = "edge", phi = 0.2, perm_h = 100,
h_a = 47, r_a = 2e4, r_R = 2e3, tetha = 360, mu_water = 0.34, c_water = 4e-6,
c_rock = 3e-6, pressure = c(3456, 3425, 3387, 3350, 3312))

aquifer_param_01

aquifer_param_02 <- aquifer_param(input_unit = "SI", output_unit = "SI",
model = "uss", flow_type = "radial", water_drive = "bottom", phi = 0.2, perm_h = 100,
perm_v = 25, h_a = 25, r_a = 6000, r_R = 600, mu_water = 0.34, c_water = 6e-7,
c_rock = 4.5e-7, pressure = c(3456, 3425, 3387, 3350, 3312) * 6.895)

aquifer_param_02

aquifer_param_03 <- aquifer_param(input_unit = "Field", output_unit = "Field",
model = "pss", flow_type = "radial", water_drive = "edge", phi = 0.2, perm_h = 100,
h_a = 47, r_a = 2e4, r_R = 2e3, tetha = 360, mu_water = 0.34, c_water = 4e-6,
c_rock = 3e-6, pressure = c(3456, 3425, 3387, 3350, 3312))

aquifer_param_03

aquifer_param_04 <- aquifer_param(input_unit = "Field", output_unit = "Field",
model = "uss", flow_type = "linear", water_drive = "edge", phi = 0.2, perm_h = 100,
h_a = 47, w_a = 30000, l_a = 10000, mu_water = 0.34, c_water = 4e-6,
c_rock = 3e-6, pressure = c(3456, 3425, 3387, 3350, 3312))

aquifer_param_04

aquifer_param_05 <- aquifer_param(input_unit = "Field", output_unit = "Field",
model = "uss", flow_type = "linear", water_drive = "bottom", phi = 0.2, perm_v = 10,
h_a = 47, w_a = 4000, l_a = 4000, mu_water = 0.34, c_water = 4e-6,
c_rock = 3e-6, pressure = c(3456, 3425, 3387, 3350, 3312))

aquifer_param_05
```

---

aquifer_predict *Generic function for cumulative water influx predictions*

Description

Generate a data frame of cumulative water influx estimates according to the class of 'aquifer_lst' and 'time_lst' objects

Usage

```
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

aquifer_lst	a list object of class 'aquifer'
time_lst	a list object of class 'time'

Value

a data frame of cumulative water influx estimates according to the class of 'aquifer_lst' and 'time_lst' objects

References

Yildiz T, Khosravi A (2007). "An Analytical Bottomwaterdrive Aquifer Model for Material-Balance Analysis." *SPE Reservoir Evaluation \& Engineering*, **10**(06), 618–628. ISSN 1094-6470, doi: 10.2118/103283PA, https://doi.org/10.2118/103283-PA.

Nabor GW, Barham RH (1964). "Linear Aquifer Behavior." *Journal of Petroleum Technology*, **16**(05), 561–563. ISSN 0149-2136, doi: 10.2118/791PA, https://doi.org/10.2118/791-PA.

Fetkovich MJ (1971). "A Simplified Approach to Water Influx Calculations-Finite Aquifer Systems." *Journal of Petroleum Technology*, **23**(07), 814–828. ISSN 0149-2136, doi: 10.2118/2603PA, https://doi.org/10.2118/2603-PA.

Van Everdingen AF, Hurst W (1949). "The Application of the Laplace Transformation to Flow Problems in Reservoirs." *Journal of Petroleum Technology*, **1**(12), 305–324. ISSN 0149-2136, doi: 10.2118/949305G, https://doi.org/10.2118/949305-G.

Examples

```
aquifer_time_1 <- aquifer_time(c(0:4) * 365, unit = "day")
aquifer_param_01 <- aquifer_param(input_unit = "Field", output_unit = "Field",
model = "uss", flow_type = "radial", water_drive = "edge", phi = 0.2, perm_h = 100,
h_a = 47, r_a = 2e4, r_R = 2e3, tetha = 360, mu_water = 0.34, c_water = 4e-6,
c_rock = 3e-6, pressure = c(3456, 3425, 3387, 3350, 3312))
results_01 <- aquifer_predict(aquifer_param_01, aquifer_time_1)

results_01
```

---

aquifer_predict.fetk_lin_bottom

S3 method for class 'aquifer_predict'

Description

Return a data frame of estimated cumulative water influx for the Fetkovich pseudo-steady state linear flow model, bottom-water-drive

Usage

```
## S3 method for class 'fetk_lin_bottom'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

aquifer_lst	a list object of class 'aquifer'
time_lst	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Fetkovich pseudo-steady state linear flow model, bottom-water-drive

---

aquifer_predict.fetk_lin_edge

S3 method for class 'aquifer_predict'

Description

Return a data frame of estimated cumulative water influx for the Fetkovich pseudo-steady state linear flow model, edge-water-drive

Usage

```
## S3 method for class 'fetk_lin_edge'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

aquifer_lst	a list object of class 'aquifer'
time_lst	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Fetkovich pseudo-steady state linear flow model, edge-water-drive

---

`aquifer_predict.fetk_rad_edge` *S3 method for class 'aquifer_predict'*

Description

Return a data frame of estimated cumulative water influx for the Fetkovich pseudo-steady state radial flow model, edge-water-drive

Usage

```
## S3 method for class 'fetk_rad_edge'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

`aquifer_lst`	a list object of class 'aquifer'
`time_lst`	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Fetkovich pseudo-steady state radial flow model, edge-water-drive

---

`aquifer_predict.nb_lin_bottom` *S3 method for class 'aquifer_predict'*

Description

Return a data frame of estimated cumulative water influx for the Nabor-Barham un-steady state linear flow model, bottom-water-drive

Usage

```
## S3 method for class 'nb_lin_bottom'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

`aquifer_lst`	a list object of class 'aquifer'
`time_lst`	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Nabor-Barham un-steady state linear flow model, bottom-water-drive

---

`aquifer_predict.nb_lin_edge`
S3 method for class 'aquifer_predict'

Description

Return a data frame of estimated cumulative water influx for the Nabor-Barham un-steady state linear flow model, edge-water-drive

Usage

```
## S3 method for class 'nb_lin_edge'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

`aquifer_lst`	a list object of class 'aquifer'
`time_lst`	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Nabor-Barham un-steady state linear flow model, edge-water-drive

---

`aquifer_predict.veh_rad_edge`
S3 method for class 'aquifer_predict'

Description

Return a data frame of estimated cumulative water influx for the Van Everdingen-Hurst un-steady state radial flow model, edge-water-drive

Usage

```
## S3 method for class 'veh_rad_edge'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

`aquifer_lst`	a list object of class 'aquifer'
`time_lst`	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Van Everdingen-Hurst un-steady state radial flow model, edge-water-drive

aquifer_predict.ykh_rad_bottom *S3 method for class 'aquifer_predict'*

Description

Return a data frame of estimated cumulative water influx for the Yildiz-Khosravi un-steady state radial flow model, bottom-water-drive

Usage

```
## S3 method for class 'ykh_rad_bottom'
aquifer_predict(aquifer_lst, time_lst)
```

Arguments

aquifer_lst	a list object of class 'aquifer'
time_lst	a list object of class 'time'

Value

a data frame of cumulative water influx estimates using the Yildiz-Khosravi un-steady state radial flow model, bottom-water-drive

aquifer_time *A list object of class 'time' for aquifer models*

Description

Create an object of class 'time'

Usage

```
aquifer_time(x, unit = "day")
```

Arguments

x	a vector of times or a daily sequence of dates
unit	time/date unit of vector x

Value

a list of class 'time' with all the required parameters for the aquifer_predict() S3 methods

Examples

```
aquifer_time_1 <- aquifer_time(c(0:4) * 365, unit = "day")

aquifer_time_1

aquifer_time_2 <- aquifer_time(c(0:4), unit = "month")

aquifer_time_2

aquifer_time_3 <- aquifer_time(c(0:4), unit = "year")

aquifer_time_3

aquifer_time_4 <- aquifer_time(seq(as.Date("2020/1/1"), by = "year",
length.out = 5), unit = "date")

aquifer_time_4
```

Index