

Package ‘Rdca’

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Title DCA Tools for Decline Rate Analysis and EUR Forecast

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Description Arps Decline Curve Analysis (DCA) models for production rate, cumulative production, nominal decline rate, the derivative of loss-ratio, and estimated ultimate recovery (EUR) predictions for oil and gas wells. Arps, J. J. (1945) <doi:10.2118/945228-G>. Robertson, S. (1988) <<https://www.onepetro.org/general/SPE-18731-MS>>.

License GPL-3

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R topics documented:

<code>decline_fit</code>	2
<code>decline_fit.exponential_fit</code>	3
<code>decline_fit.harmonic_fit</code>	3
<code>decline_fit.hyperbolic_fit</code>	4

decline_fit.modified_hyperbolic_fit	4
decline_fit_param	5
decline_param	6
decline_predict	7
decline_predict.exponential	9
decline_predict.harmonic	9
decline_predict.hyperbolic	10
decline_predict.modified_hyperbolic	11
decline_time	11

Index	13
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decline_fit	<i>Arps decline_fit prediction</i>
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Description

Generate a list of estimates for the Arps decline model according to the class of 'decline_fit_lst' and 'time_lst' objects

Usage

```
decline_fit(decline_fit_lst, time_lst)
```

Arguments

decline_fit_lst	a list object of class 'decline_fit'
time_lst	a list object of class 'time'

Value

a list of estimates for the parameters of the Arps model according to the class of 'decline_fit_lst' and 'time_lst' objects

Examples

```
dcl_time_hyp <- decline_time(1:10000, unit = "day")
prod_data <- 4500 / (1 + 0.002 * 0.834 * dcl_time_hyp$t) ^ (1 / 0.834)
dcl_fit_param_hyp <- decline_fit_param(input_unit = "Field", output_unit = "Field",
fluid = "gas", model = "hyperbolic", fit_data = "rate", prod_data = prod_data,
initial_param = c(1000, 0.01, 1.0), lower = c(0, 1e-6, 1e-6), upper = NULL,
control = list(maxiter = 100))
dcl_fit_hyp <- decline_fit(dcl_fit_param_hyp, dcl_time_hyp)

dcl_fit_hyp
```

```
decline_fit.exponential_fit  
    S3 method for class 'decline_fit'
```

Description

Return a list of estimated parameters for the Arps exponential decline model

Usage

```
## S3 method for class 'exponential_fit'  
decline_fit(decline_fit_lst, time_lst)
```

Arguments

```
decline_fit_lst  
    a list object of class 'decline_fit'  
time_lst  
    a list object of class 'time'
```

Value

a list of estimates for the parameters of the Arps exponential model

```
decline_fit.harmonic_fit  
    S3 method for class 'decline_fit'
```

Description

Return a list of estimated parameters for the Arps harmonic decline model

Usage

```
## S3 method for class 'harmonic_fit'  
decline_fit(decline_fit_lst, time_lst)
```

Arguments

```
decline_fit_lst  
    a list object of class 'decline_fit'  
time_lst  
    a list object of class 'time'
```

Value

a list of estimates for the parameters of the Arps harmonic model

```
decline_fit.hyperbolic_fit  
      S3 method for class 'decline_fit'
```

Description

Return a list of estimated parameters for the Arps hyperbolic decline model

Usage

```
## S3 method for class 'hyperbolic_fit'  
decline_fit(decline_fit_lst, time_lst)
```

Arguments

```
decline_fit_lst  
      a list object of class 'decline_fit'  
time_lst      a list object of class 'time'
```

Value

a list of estimates for the parameters of the Arps hyperbolic model

```
decline_fit.modified_hyperbolic_fit  
      S3 method for class 'decline_fit'
```

Description

Return a list of estimated parameters for the Arps modified_hyperbolic decline model

Usage

```
## S3 method for class 'modified_hyperbolic_fit'  
decline_fit(decline_fit_lst, time_lst)
```

Arguments

```
decline_fit_lst  
      a list object of class 'decline_fit'  
time_lst      a list object of class 'time'
```

Value

a list of estimates for the parameters of the Arps modified_hyperbolic model

 decline_fit_param *Arps decline_fit object*

Description

Create an object of class 'decline_fit'

Usage

```
decline_fit_param(
  input_unit = "Field",
  output_unit = "Field",
  fluid = "oil",
  model = "exponential",
  fit_data = "rate",
  prod_data,
  initial_param,
  lower = NULL,
  upper = NULL,
  control = 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'
fluid	fluid type, a character string either 'oil' or 'gas'
model	decline model, a character string. 'exponential', 'harmonic', 'hyperbolic', and 'modified_hyperbolic' models are currently available
fit_data	a character string, either 'rate', or 'cum'
prod_data	a numeric vector of rates or cumulative according to 'fit_data'
initial_param	a numeric vector of initial estimates for the Arps decline model
lower	an optional numeric vector of lower bounds for the Arps decline model parameters. See 'minpack.lm' package for details
upper	an optional numeric vector of upper bounds for the Arps decline model parameters. See 'minpack.lm' package for details
control	an optional list of control settings. See 'minpack.lm' package for details

Value

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

Examples

```

prod_data <- 3000 * exp(-0.00234 * c(1:300))
dcl_fit_param_exp <- decline_fit_param(input_unit = "Field", output_unit = "Field",
fluid = "oil", model = "exponential", fit_data = "rate", prod_data = prod_data,
initial_param = c(1000, 0.1, 0), lower = NULL, upper = NULL, control = NULL)

dcl_fit_param_exp

prod_data <- 4500 / (1 + 0.002 * 0.834 * c(1:400)) ^ (1 / 0.834)
dcl_fit_param_mod_hyp <- decline_fit_param(input_unit = "Field", output_unit = "Field",
fluid = "oil", model = "modified_hyperbolic", fit_data = "rate", prod_data = prod_data,
initial_param = c(10000, 0.1, 0.8, 0.01), lower = NULL, upper = NULL,
control = list(maxiter = 100))

dcl_fit_param_mod_hyp

```

decline_param	<i>Arps decline object</i>
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Description

Create an object of class 'decline'

Usage

```

decline_param(
  input_unit = "Field",
  output_unit = "Field",
  fluid = "oil",
  model = "exponential",
  qi = NULL,
  Di = NULL,
  b = NULL,
  Dt = NULL,
  q_abnd = 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'
fluid	fluid type, a character string either 'oil' or 'gas'
model	decline model, a character string. 'exponential', 'harmonic', 'hyperbolic', and 'modified_hyperbolic' models are currently available

qi	Arp's decline parameter, a numeric value. Depending on the 'input_unit', 'fluid' type, and also the decline_time() 'unit' parameter, it has different units. 'm3/day' for gas production in 'SI' unit with daily data, 'm3/month' for gas production in 'SI' unit with monthly data, 'MSCF/day' for gas production in 'Field' unit with daily data, 'MSCF/month' for gas production in 'Field' unit with monthly data, 'm3/day' for oil production in 'SI' unit with daily data, 'm3/month' for oil production in 'SI' unit with monthly data, 'bbl/day' for oil production in 'Field' unit with daily data, and 'bbl/month' for oil production in 'Field' unit with monthly data
Di	Arp's nominal decline parameter, a numeric value in '1/day', '1/month', or '1/year' depending on the decline_time() 'unit' parameter
b	Arp's decline parameter. It is zero for the 'exponential' model, one for the 'harmonic' model, and a value between zero and one for the 'hyperbolic' model. For unconventional reservoirs, b values more than one are also reported
Dt	Arp's "modified_hyperbolic" nominal terminal decline parameter, a numeric value in '1/day', '1/month', or '1/year' depending on the decline_time() 'unit' input
q_abnd	abandonment rate, a numeric value defaulted to NULL. If present, the model predicts the time to reach to the abandonment rate and also the estimated ultimate recovery (EUR) till the abandonment time. It has the same unit as 'qi'.

Value

a list of class 'decline' with all the required parameters for the decline_predict() S3 methods

Examples

```
decline_param_1 <- decline_param(input_unit = "Field", output_unit = "Field", fluid = "oil",
model = "exponential", qi = 1000, Di = 0.15, b = 0, q_abnd = NULL)
```

```
decline_param_1
```

```
decline_param_2 <- decline_param(input_unit = "Field", output_unit = "SI", fluid = "oil",
model = "hyperbolic", qi = 15000, Di = 0.1, b = 0.95, q_abnd = 200)
```

```
decline_param_2
```

```
decline_param_3 <- decline_param(input_unit = "Field", output_unit = "Field", fluid = "gas",
model = "modified_hyperbolic", qi = 100000, Di = 0.15, b = 0.85, Dt = 0.005, q_abnd = NULL)
```

```
decline_param_3
```

Description

Create a data frame of decline predictions according to the class of 'decline_lst' and 'time_lst' objects

Usage

```
decline_predict(decline_lst, time_lst)
```

Arguments

decline_lst	a list object of class 'decline'
time_lst	a list object of class 'time'

Value

a data frame of decline estimates according to the class of 'decline_lst' and 'time_lst' objects

References

Arps JJ (1945). "Analysis of Decline Curves." *Transactions of the AIME*, **160**(01), 228–247. ISSN 0081-1696, doi: [10.2118/945228G](https://doi.org/10.2118/945228G), <https://doi.org/10.2118/945228-G>.

Robertson S (1988). "Generalized Hyperbolic Equation."

Examples

```
decline_param_1 <- decline_param(input_unit = "Field", output_unit = "Field",
fluid = "oil",
model = "exponential", qi = 1000, Di = 0.15, b = 0, q_abnd = NULL)
decline_time_1 <- decline_time(c(1:7300), unit = "day")
decline_predict_1 <- decline_predict(decline_param_1, decline_time_1)

head(decline_predict_1)

decline_param_2 <- decline_param(input_unit = "Field", output_unit = "SI",
fluid = "oil",
model = "hyperbolic", qi = 15000, Di = 0.1, b = 0.95, q_abnd = 200)
decline_time_2 <- decline_time(seq(as.Date("2016/04/15"), by = "days",
length.out = 3600), unit = "date")
decline_predict_2 <- decline_predict(decline_param_2, decline_time_2)

head(decline_predict_2)
```

```
decline_predict.exponential  
      S3 method for class 'decline_predict'
```

Description

Create a data frame of exponential decline predictions

Usage

```
## S3 method for class 'exponential'  
decline_predict(decline_lst, time_lst)
```

Arguments

```
decline_lst    a list object of class 'decline'  
time_lst      a list object of class 'time'
```

Value

a data frame of decline estimates using the Arps exponential model

References

Arps JJ (1945). "Analysis of Decline Curves." *Transactions of the AIME*, **160**(01), 228–247. ISSN 0081-1696, doi: [10.2118/945228G](https://doi.org/10.2118/945228G), <https://doi.org/10.2118/945228-G>.

```
decline_predict.harmonic  
      S3 method for class 'decline_predict'
```

Description

Create a data frame of harmonic decline predictions

Usage

```
## S3 method for class 'harmonic'  
decline_predict(decline_lst, time_lst)
```

Arguments

```
decline_lst    a list object of class 'decline'  
time_lst      a list object of class 'time'
```

Value

a data frame of decline estimates using the Arps harmonic model

References

Arps JJ (1945). "Analysis of Decline Curves." *Transactions of the AIME*, **160**(01), 228–247. ISSN 0081-1696, doi: [10.2118/945228G](https://doi.org/10.2118/945228G), <https://doi.org/10.2118/945228-G>.

decline_predict.hyperbolic
S3 method for class 'decline_predict'

Description

Create a data frame of hyperbolic decline predictions

Usage

```
## S3 method for class 'hyperbolic'  
decline_predict(decline_lst, time_lst)
```

Arguments

decline_lst a list object of class 'decline'
time_lst a list object of class 'time'

Value

a data frame of decline estimates using the Arps hyperbolic model

References

Arps JJ (1945). "Analysis of Decline Curves." *Transactions of the AIME*, **160**(01), 228–247. ISSN 0081-1696, doi: [10.2118/945228G](https://doi.org/10.2118/945228G), <https://doi.org/10.2118/945228-G>.

```
decline_predict.modified_hyperbolic
      S3 method for class 'decline_predict'
```

Description

Create a data frame of modified_hyperbolic decline predictions

Usage

```
## S3 method for class 'modified_hyperbolic'
decline_predict(decline_lst, time_lst)
```

Arguments

```
decline_lst    a list object of class 'decline'
time_lst       a list object of class 'time'
```

Value

a data frame of decline estimates using the Arps modified_hyperbolic model

References

Arps JJ (1945). "Analysis of Decline Curves." *Transactions of the AIME*, **160**(01), 228–247. ISSN 0081-1696, doi: [10.2118/945228G](https://doi.org/10.2118/945228-G), <https://doi.org/10.2118/945228-G>.

```
decline_time      Arps time object
```

Description

Create an object of class 'time'

Usage

```
decline_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 decline_predict() S3 methods

Examples

```
decline_time_1 <- decline_time(c(1:730), unit = "day")
```

```
decline_time_1
```

```
decline_time_2 <- decline_time(c(1:240), unit = "month")
```

```
decline_time_2
```

```
decline_time_3 <- decline_time(c(1:15), unit = "year")
```

```
decline_time_3
```

```
decline_time_4 <- decline_time(seq(as.Date("2020/1/1"), by = "days",  
length.out = 360), unit = "date")
```

```
decline_time_4
```

Index

`decline_fit`, [2](#)
`decline_fit.exponential_fit`, [3](#)
`decline_fit.harmonic_fit`, [3](#)
`decline_fit.hyperbolic_fit`, [4](#)
`decline_fit.modified_hyperbolic_fit`, [4](#)
`decline_fit_param`, [5](#)
`decline_param`, [6](#)
`decline_predict`, [7](#)
`decline_predict.exponential`, [9](#)
`decline_predict.harmonic`, [9](#)
`decline_predict.hyperbolic`, [10](#)
`decline_predict.modified_hyperbolic`,
[11](#)
`decline_time`, [11](#)