Units and Formula Symbols

Units and their unit prefixes are used for the numerical representation of physical parameters (Table 1).

The **Technical Units System** and the **CGS System** used in parallel have been replaced by the mandatory **International System of Units (SI)** since July 5, 1970 (Tables 2 and 3).

Formula Symbols, Units, and Parameters

- The different units can be easily converted using the following link: www.unitconverters.net
- The internationally used formula symbols and indices are listed in Table 4.
- The formula symbols for **physical** parameters are shown in cursive print (*italics*) in the equations and formulas. The interdisciplinary parameters are mostly selected according to DIN 1304 and freely selected indices are used for a finer subclassification.
- The various units for **pressure** are adjusted. However, they can also be easily converted: 1 bar $= 10^5$ Pa $= 10.19716$ m water column (mWC), 1 mWC $= 98.0665$ mbar, 1 mbar $= 1$ hPa, and 1 kp/cm^2 $= 1$ at. Other examples of conversion can be found in Kurzweil (2000).
- Due to the font in the text, there may be **confusion** with the following units: l $=$ liter, not to be confused with 1 $= 1$ (number); $v =$ v (cursive) $=$ velocity, not to be confused with ν (ny $=$ Greek letter) $=$ kinematic viscosity; and the same with $m =$ m (cursive) $=$ mass and m $=$ meter.
  Usually the letter l (lower case) is the symbol for liter. To prevent confusion between the number 1 (one) and the letter l, the use of the letter L (upper case) for liter is allowed.
- Ratios, concentrations, and other **dimensionless** parameters are pure numbers (usually smaller than 1). They are often given in %. Because % represents a pure number ratio, namely % $= 1/100$ or $100\% = 1$, the calculated decimal fractions can be multiplied by 100%, e.g., $\varphi = 0.73 = 0.73 \cdot 100\% = 73\%$. When inserting such parameters in equations, however, these values should be used as decimal fractions, i.e., $\varphi = 0.73$ in this case.

Table 1 Unit prefixes (according to DIN 1301)

Multiplication Factor	Name	Symbol	Remark
10^{24}	Yotta	Y	
10^{21}	Zetta	Z	
10^{18}	Exa	E	$18 = 6 \cdot 3$ (6 $=$ hexa)
10^{15}	Peta	P	$15 = 5 \cdot 3$ (5 $=$ penta)
10^{12}	Tera	T	also T $=$ Tesla (magnetic flux density)
10^{9}	Giga	G	also G $=$ Gauß (no longer valid)
10^{6}	Mega	M	
10^{3}	Kilo	K	
10^{2}	Hecto	H	also h $=$ hour (time)
10^{1}	Deca	Da	caution: not d $\cdot$ a
10^{-1}	Deci	D	also d $=$ day (time)
10^{-2}	Centi	C	
10^{-3}	Milli	M	also m $=$ meter (length)
10^{-6}	Micro	μ	
10^{-9}	Nano	N	
10^{-12}	Pico	P	also p $=$ pound (no longer valid)
10^{-15}	Femto	F	also $f =$ frequency
10^{-18}	Atto	A	also a $=$ year/annual (time), also a $=$ acre
10^{-21}	Zepto	Z	
10^{-24}	Yocto	Y	

Table 2 Parameters and their system of units

Parameter	Formula symbol	Unit systems		
		International System of Units (SI)	CGS System	Technical System
Length	l	M	cm	m
Time	t	S	S	s
Mass	M	Kg	g	$\left(\frac{kp \cdot s^2}{m}\right)$
Force	F	$N \text{ (Newton)} = \frac{kg \cdot m}{s^2}$	$dyn = \frac{g \cdot cm}{s^2}$	kp
Work, energy	W	$J = N \cdot m = \frac{kg \cdot m^2}{s^2} = W \cdot s \text{ (J = Joules)}$	$erg = dyn \cdot cm = \frac{g \cdot cm^2}{s^2}$	kp·m
Power	P	$W = \frac{J}{s} = \frac{N \cdot m}{s} = \frac{k \cdot m^2}{s^3} \text{ (W = Watt)}$	$\frac{erg}{s} = \frac{g \cdot cm^2}{s^3}$	$\frac{kp \cdot m}{s}$
Moment of a force	M	$N \cdot m = \frac{kg \cdot m^2}{s^2}$	$dyn \cdot cm = \frac{g \cdot cm^2}{s^2}$	kp·m
Pressure	P	$Pa \text{ (Pascal)} = \frac{N}{m^2} = \frac{kg}{s^2 \cdot m}$	$\frac{dyn}{cm^2} \left(bar = 10^6 \frac{dyn}{cm^2}\right)$	$\frac{kp}{m^2} \left(at = \frac{kp}{cm^2}\right)$
Density	ρ (rho)	$\frac{kg}{m^3}$	$\frac{g}{cm^3}$	$\frac{kp \cdot s^2}{m^4}$
Dynamic viscosity	η (eta)	$Pa \cdot s = \frac{N \cdot s}{m^2} = \frac{kg}{s \cdot m}$	$P \text{(Poise)} = \frac{dyn \cdot s}{cm^2}$	$\frac{kp \cdot s}{m^2}$
Kinematic viscosity	$\nu = \frac{\eta}{\rho}$ (ny)	$\frac{m^2}{s}$	$St \text{(Stockes)} = \frac{cm^2}{s}$	$\frac{m^2}{s}$

Table 3 Basic parameters and SI basic units

Parameter	Formula symbol	SI—basic units	
		Name	Symbol
Length	L	Meter	m
Mass	m	Kilogram	kg
Time	t	Second	S
Electric current	I	Ampere	A
Thermodynamic temperature	T	Kelvin	K
Substance quantity	n	Mol	Mol
Luminous intensity	I	Candela	Cd

- Some parameters referring to **time units** contain a formula symbol with a point above it, e.g., $\dot{h} = dh/dt$ and $\dot{V} = dV/dt$ (Table 4: Formula symbols, Units, and Parameters).
  Since the MS Office version 2007, formulas can be edited in MS Word and MS Excel, which was only possible using external programs (e.g., MathType) in the past. The creation of formulae is easy to learn and is identical for all MS Office programs. In the following, the creation of the formula symbol for discharge $\dot{V}$ and various indices will be shown:
  - In the top menu bar under "Insert," click on the "Equation" button to enter a formula freely.
  - An Equationbox will be opened in the top menu bar, the category "Formula tools—draft."
  - To create the $\dot{V}$, start by entering a V in the formula symbol, mark it, and then give it a simple point as an "accent."
  An index can be inserted as follows:
  - First create a "script" with the option "subscript."
  - Two dotted boxes appear, in which the corresponding formula symbols and indices can be inserted. To place a point over the formula symbol, mark only the bigger box and create an accent (see above).
  - As a standard, the index is set in italics and can be subsequently changed using the "Font options."
  - The formula tools can be combined freely. It is very helpful for beginners to follow the formula examples suggested in the selection list. The chemical units and conversion factors were all taken from Küster and Thiel (2003).

Table 4 Formula symbols, Units, and Parameters

Formula symbol	Units	Parameter/term
A	m^2	Area, area cross-section, flow area cross-section, filter area cross-section
A_{cb}	km^2	Area of the catchment basin
A_{cbs}	km^2	Area of the corresponding surface catchment basin
A_{cbu}	km^2	Area of the corresponding underground catchment basin
A_{tot}	m^2	Total area
A_{cir}	mm^2	Area of the circular chart
A_n	m^2	Subarea between the isohyets $\dot{h}_{n1}$ and $\dot{h}_{n2}$
$A_{1,2,..}$	km^2	Subareas 1,2,... of the observed area
A_{sa}	m^2	(Soil) sample area cross-section
A_{tu}	m^2	Measuring tube area cross-section
$a(ox)$	mol/l	Activity of the oxidized form of the substance
$a(red)$	mol/l	Activity of the reduced form of the substance
$a(X)$	mol/l	Activity of ion X
a_{rs}	pMC	Activity (of a radioactive substance) (percent modern carbon)
a_{ini}	pMC	Initial activity (of a radioactive substance)
B	M	Width, width of contribution
$b(X)$	mol/kg	Molarity
C_w	1/(hPa)	Absorption coefficient of the gas in pure water
C_s	1/(hPa)	Absorption coefficient of the gas in the solution at a given ionic strength
c_{ads}	mg/kg	Concentration of an adsorbed substance
c_{Clgw}	mg/l	Chloride concentration in the groundwater
c_{ClP}	mg/l	Chloride concentration in the precipitation
c_{sol}	mg/l	Concentration of a substance in the solution
c_{AmBn}	mol/l	Molar solubility of compound A_mB_n
c_0	mol/l	Initial concentration of a substance in the solution
c_{wfl}	mol/l	Concentration (of the index ion) in the fluvial/river water
c_{gw}	mol/l	Concentration (of the index ion) in the corresponding groundwater
c_{wmix}	mol/l	Concentration (of the index ion) in the corresponding mixed water
c_t	mol/l	Concentration of a substance at a given time
$c(X)$	mol/l	Molar concentration of the substance or ion X
$c\left(\frac{1}{z}X\right)$	mol/l	Equivalent concentration of the substance X
c_p	kJ/(kg·K)	Specific heat capacity at constant pressure
c_v	kJ/(kg·K)	Specific heat capacity at constant volume (J = Joule (work, energy)) (K = Kelvin (absolute temperature))
d	m	Diameter $= 2r$
d_{bh}	m	Borehole diameter
d_{fi}	m	Filter diameter
d_{ion}	pm	Ionic diameter
d_g	mm	Grain size, grain diameter
d_{g10}	mm	Grain size at a grain size fraction of 10%
d_{g60}	mm	Grain size at a grain size fraction of 60%
d_{paeff}	mm	Effective grain size of the aquifer according to Hazen $= d_{g10}$
d_{ggf}	m	Grain diameter of the inner gravel fill surrounding the filter tube
d_{Ee}	1000‰ = 1	Deuterium excess
E	$Pa = N/m^2$ (Pascal)	Elastic modulus, $E = 1/\chi$
E	1	Extinction, absorption (common logarithm of the reciprocal value of the (light flux) transmittance τ)
EMF	mV	Electromotive force
E_H	mV	Redox potential of the solution (V = Volt (electric potential))
E_N	mV	Nernst voltage
E_0	mV	Standard redox potential (for 298 K and 10^5 Pa)

(continued)

Table 4 (continued)

Formula symbol	Units	Parameter/term
E_ϑ	mV	Redox potential at a given water temperature ϑ
E	100% = 1	Void ratio
E	1	Universal constant = 2.7182818 (base for the natural logarithm ln)
F	J/(V·mol)	Faraday constant = 96.484 · 10^3 J/(V·mol)
FC	mm/dm l/m³	Field capacity
F	1	Activity coefficient
F	Hz = 1/s (Hertz)	Frequency
f_w	Hz = 1/s	Natural frequency of water
f_{La}	1	Langelier correction factor
f_{Mn}	1	Permanganate factor
f_{Sch}	mm/ (°C·month)	Schendel coefficient = 4.8 mm/(°C·month)
f_{Ti}	1	Tillmans correction factor
G	S = 1/Ω (Siemens)	Electrical conductance = $1/R$ (Ω = Ohm (electrical resistance))
G	J/mol	Molar free enthalpy (Gibbs energy) (J = Joule (work, energy))
G	m/s²	Local gravitational acceleration ≈ 9.81 m/s²
H	J/mol	Molar enthalpy (J = Joule (work, energy))
dH	°dH	German degrees of hardness (deutsche Härte)
TH	°dH	Total hardness
CH	°dH	Carbonate hardness
NCH	°dH	Non-carbonate hardness (mineral hardness)
^{3}H	TU (tritium units)	^{3}H concentration
h	m	Height, elevation, Rise height due to suction (soil moisture tension), Hydraulic head (potential)
h	m	(Pressure) height difference (amount by which the water column was changed)
h_{bh}	m	Height of the groundwater level in the borehole above the borehole base
h_{well}	m	Height of the operating water level in the extraction well above the reference level
h_{fi}	m	Filter length of a well
h_g	m	Height of the non-lowered groundwater level above the reference level at a distance r_{th}
h_{gw}	m	Height of the groundwater level (outside of the borehole above the borehole base)
h_{th}	m	Groundwater thickness, thickness
$h_{thkfmin}$	m	Thickness of the least permeable single layer
h_{thL}	m	Groundwater thickness in the lowered state
h_s	m	Drawdown/Depression height, recovery height
h_{swell}	m	Drawdown or recovery height in the well
$h_{swellbo}$	m	Lowered water level above the well bottom
h_{scor}	m	Corrected drawdown
h_{srt}	m	Drawdown at the distance r from the abstraction site at the time t
h_{s1}	cm	Drawdown of the water level compared to the at-rest water level (Natermann)
h_{s2}	cm	Recovery height of the water level after the time interval t (Natermann)
h_{po}	m	Overpressure head
h_w	m	Water level, height of the water surface
h_1	m	Height of the higher groundwater equipotential line
h_2	m	Height of the lower groundwater equipotential line
h_1, h_2	m	Pressure heads before and after performing the test
$\dot{h}$	mm/a l/(s·km²) l/(a·m²) m³/(a·km²)	… rate $\dot{h} = dh/dt$ … yield $\dot{h} = \dot{V}/A$

Table 4 (continued)

Formula symbol	Units	Parameter/term
$\dot{h}_R$	mm/a	Total runoff rate
$\dot{h}_{Rdir}$	mm/a	Direct runoff rate
$\dot{h}_{Perl}$	mm/a	Percolation rate of the lysimeter
$\dot{h}_{Perlm}$	mm/a	Long-term mean of the percolation rate of the lysimeter
$\dot{h}_D$	mm/a	(Subsurface) discharge rate
$\dot{h}_{Dsp}$	l/(km^2·s)	Specific discharge, partial specific discharge rate per unit area
$\dot{h}_{Dmom}$	l/(km^2·s)	Monthly mean low water specific discharge (Wundt method)
$\dot{h}_{Dcbs}$	l/(km^2·s)	Total specific discharge per unit area of a surface catchment basin
$\dot{h}_{co}$	mm/a	Consumption
$\dot{h}_E$	mm/a	Evaporation rate
$\dot{h}_{ET}$	mm/a	Evapotranspiration rate
$\dot{h}_{ETpot}$	mm/a mm/month mm/d	Potential evapotranspiration rate
$\dot{h}_{ETact}$	mm/a	Actual evapotranspiration rate
$\dot{h}_{gw}$	mm/a or 1/(s·km^2)	Groundwater recharge rate or groundwater recharge yield
$\dot{h}_I$	mm/a	Infiltration rate
$\dot{h}_{cwb}$	mm/a	Climatic water balance
$\dot{h}_{cwbam}$	mm/a	Mean annual climatic water balance
$\dot{h}_{diffam}$	mm/a	Long-term mean annual value of the difference between the precipitation rate $\dot{h}_{Pam}$ and the height of the lysimeter percolation water discharge $\dot{h}_{Perlam}$
$\dot{h}_E$	mm/a	Evaporation rate
$\dot{h}_{Eam}$	mm/a	Long-term annual mean of the evaporation rate
$\dot{h}_{Eact}$	mm/a	Actual evaporation rate
$\dot{h}_m$	mm/a	Soil moisture content/infiltration rate
$\dot{h}_P$	mm/a	Precipitation rate
$\dot{h}_{Par}$	mm/a	Precipitation rate in an area
$\dot{h}_{Parm}$	mm/a	Areal mean of the precipitation rates
$\dot{h}_{Pam}$	mm/a	Mean annual precipitation rate
$\dot{h}_{Perlam}$	(mm/a)	Mean annual percolation rates of lysimeter
$\dot{h}_{Pi}$	mm/min	Precipitation intensity
$\dot{h}_{Psp}$	l/(s·ha)	Precipitation yield
$\dot{h}_{P1,2}$	mm/a	Precipitation rate in subareas 1, 2, 3…
$\dot{h}_{res}$	mm/a	Reserve
$\dot{h}_T$	mm/a	Transpiration rate
$\dot{h}_U$	mm/a	Difference between the percolation rates at the simultaneous precipitation rate $\dot{h}_P$
I	mol/l	Ionic strength
I	1	Heat index
I_{ap}	mol^2/l^2	Ion activity product
I_{La}	1	Langelier (calcium carbonate saturation) index
I_{Mn}	mg/l	Permanganate index
I_{sat}	1	Saturation index
I_d	mm/(°C·a)	Drought index
i	100% = 1	hydraulic gradient, $(h_1-h_2)/l$
i_0	100% = 1	Groundwater gradient before the water abstraction
i_+	A/m^2	Current flow, anodic
i_-	A/m^2	Current flow, cathodic

(continued)

Table 4 (continued)

Formula symbol	Units	Parameter/term
i_a	A/m^2	Exchange current density (A = Ampère (electrical current))
j_{adv}	$kg/(m^2 \cdot s)$	Advective material flow
j_{difu}	$kg/(m^2 \cdot s)$	Diffusive material flow
j_{disp}	$kg/(m^2 \cdot s)$	Dispersive material flow
K	m^2 D (Darcy)	Permeability coefficient $1\ D = 0.9869 \cdot 10^{-12}\ m^2$
K	1	Reaction-dependent equilibrium constant
K_D	1	Correction factor for the discharge
K_{AB}	1	Dissociation constant for substance AB
K_{ads}	1	Adsorption coefficient
K_{La}	mol/l	Langelier constant
K_{ocw}	1	Distribution ratio of a substance in octanol/water
K_{Ti}	$l^2/mmol^2$	Tillmans constant
K_w	mol^2/l^2	Ion product of water
K_1, K_2	1	Dissociation constant
CEC	mmol/100 g	Cation exchange capacity (related to equivalent substance quantity
K	1	Damping coefficient
K	l/kg	Substance-specific constant (Freundlich isotherm)
K	1/m	Proportionality factor
k_{adv}	m/s	Advection term
k_f	m/s	Coefficient of permeability
k_{fmin}	m/s	Minimum coefficient of permeability of the single lowest permeability layer
k_{fv}	m/s	Vertical coefficient of permeability
k_T	$g \cdot s/cm^4$	Coefficient (dyes)
$K(X)$	mol/g	Conversion factor for ion X
L	$cm^3/cm^3 = 1$	Solubility
L_{AB}	mol^{m+n}/l^{m+n}	Reaction-dependent solubility product
L	m	Length, distance, interval, characteristic length of the soil sample, filter length, flow length
L	m	Free borehole section
l_a	m	Distance from the culmination point to the abstraction site
l_B	m	True trajectory length
$l_{b/2}$	m	Half-width of contribution
L_{wellba}	m	Distance well—bank
L_{fi}	m	Filter length, seepage section of a horizontal collector well
l_{spfi}	m	Slit length of the seepage filter
L_r	m	Range (or r_{max})
$M(X)$	g/mol	Molar mass
M	kg	Mass
m_{som}	g	Mass of the solid material
m_{solv}	g	Mass of the solvent
m_{sol}	g	Mass of the solution
$\dot{m}$	kg/s	Mass flow $\left(\dot{m} = \dfrac{m}{t}\right) dm/dt$
N_A	1/mol	Avogadro constant: Number of particles per mol = $6.022 \cdot 10^{23}/mol$
N	1	Number of transferred electrons
N	1	Number of measurements
n_{Pamd}	1	Mean annual number of precipitation days with a precipitation rate of $\dot{h}_P \geq 0$ mm/d
n_v	1	Number of transferred H^+ electrons
n_{120}	1	Constant = 120 = mean annual number of precipitation days with a precipitation rate $\dot{h}_P \geq 1.0$ mm/d for the whole of Germany
N	1/s = Hz	Rotation per minute (rotational frequency)

Table 4 (continued)

Formula symbol	Units	Parameter/term
n	100% = 1	Substance-specific constant (Freundlich isotherm)
n_{Rdir}	1	Fraction of the direct runoff in the total runoff
n_{peff}	100% = 1	Effective or discharge-producing porosity
n_j	100% = 1	Joint ratio
n_p	100% = 1	Porosity
n_{peff}	100% = 1	Effective or discharge-producing porosity
$n_{storeff}$	100% = 1	Effective storage
n_{aw}	100% = 1	Specific retention
aFC	hPa	Plant-available water
$n(X)$	mol	Substance quantity
P	Pa = N/m^2	Pressure (Pascal = N/m^2; 1 bar = 10^5 Pa)
p_{part}	Pa	Partial pressure of the gas Partial pressure of the gas above the water
p_{abs}	Pa	Absolute pressure within the groundwater
p_{amb}	Pa	Atmospheric pressure
p_v	Pa	Vapor pressure
p_{vsat}	Pa	Saturation vapor pressure
p_{vsat14}	Pa	Saturation vapor pressure of the air at 14:00 o'clock
p_g	Pa	Hydrostatic pressure
p_{po}	Pa	Overpressure on the manometer
P	C·m	Electric dipole moment
pE	1	pE-value (common logarithm of the "electron activity")
pF	1	pF-value (logarithm of the suction head in the soil)
pH	1	pH-value (negative common logarithm of the hydrogen ion concentration)
pH$_{sat}$	1	pH-value of natural water in lime–carbonic acid equilibrium
pK$_{La}$	1	Logarithm of the temperature-dependent (Langelier) constant
Q	C (Coulomb)	Electrical charge C = A·s (A = Ampère)
Q_S	W/m^2	Net total radiation (W = Watt (power))
Q	m/s	Specific discharge
R	Ω (Ohm)	Electrical resistance = 1/G
R	mg/l	Residue on evaporation
R	1	Retardation factor
R	J/(mol·K)	Universal gas constant = 8.314 J/(mol · K) (J = Joule (work, energy)) (K = Kelvin (absolute temperature))
Re	1	Reynolds number
Re_k	1	Threshold value for the Re number for laminar flow
R_{saO}	1	$^{18}O/^{16}O$ = Isotope ratio in the water sample
R_{stO}	1	$^{18}O/^{16}O$ = Isotope ratio in the standard
R	m	Radius; $r = d/2$
r_{well}	m	Well radius
r_{cir}	mm	Radius of the circular chart
r_g	m	Estimated or measured range of the drawdown
r_0	m	Distance well—culmination point
r_{50}	m	50-day line
r^2_{50}	m	Distance to the boundary range of Zone II from the abstraction plant
rH	1	rH value (negative common logarithm of the hydrogen partial pressure)
S	J/(mol·K)	Molar entropy (J = Joule (work, energy)) (K = Kelvin (absolute temperature))
S	m^3/m^3 = 1	Storage coefficient
S_{sp}	1/m	Specific storage coefficient
$\dot{S}$	kg/(m^3·s)	Storage per unit of time

Table 4 (continued)

Formula symbol	Units	Parameter/term
S_F	1	Skin factor
S	1	Slope of the "precipitation line"
S	m	Layer thickness (for the determination of the spectral absorption coefficient SAC)
T T_0	K (Kelvin)	Absolute temperature ($= 273$ K for $\vartheta_0 = 0$ °C)
T_{gw}	m²/s	Transmissivity
T	s, min, h, d, a	Time, period of time/time interval
$T_{1/2}$	s, min, h, d, a	Half-life (e.g., the activity of a radionuclide)
T_{ag}	a	Age
T_{pu}	h, d	Pumping time
t_{rr}	h, d	Recovery time
$t_{1/2}$	s, min, h, d, a	Hydrological half-life
U	J/mol	Molar bond energy (internal energy)
U	$100\% = 1$	Irregularity parameter
U	1	Integration variable of the Theis well function W(u)
V	m³	Volume
V_{so}	m³	Volume of solids
V_{tot}	m³	Total volume
V_{gwd}	m³	Drainable groundwater volume, drainable groundwater volume stored at the time of discharge
V_{adhw}	m³	Adhesive water volume
V_j	m³	Joint volume
V_{sol}	m³	Volume of the solution
V_p	m³	Pore volume, total pore volume
V_{peff}	m³	Effective pore volume
V_{gw}	m³	Groundwater volume
V_{gw50}	m³	Abstraction volume in 50 days
$V_{D\Delta t}$	m³	Discharged volume between the measurements with the time interval Δt
V_w	m³	Water volume
$\dot{V}$	m³/s	Discharge $\dot{V} = dV/dt$
$\dot{V}$	m³/s	Groundwater outflow rate
$\dot{V}$	m³/s	Grouting rate
$\dot{V}$	m³/s	Inflowing water volume per unit of time
$\dot{V}$	m³/s	Intended abstraction rate of a well
$\dot{V}_D$	m³/s	Discharge rate (discharge, outflow)
$\dot{V}_{cb}$	m³/s	Discharge pumped out of the catchment basin per unit of time
$\dot{V}_{Dmoml}$	m³/s	Long-term monthly low water discharge rate
$\dot{V}_{Dmt}$	m³/s	Mean discharge at the time t of the measurement
$\dot{V}_R$	m³/s	(Surface) runoff rate
$\dot{V}_D$	m³/s	(Subsurface) discharge rate
$\dot{V}_{Dm}$	m³/s	Mean groundwater discharge rate
$\dot{V}_{storcwell}$	m³/s	Storage capacity of the well
$\dot{V}_H$	m³/s	Maximum value of the discharge rate
$\dot{V}_{HH}$	m³/s	Highest recorded discharge rate
$\dot{V}_m$	m³/s	Long-term mean abstraction rate
$\dot{V}_{mH}$	m³/s	Arithmetic mean of the maximum discharge rate values in similar periods of time
$\dot{V}_{mL}$	m³/s	Arithmetic mean of the lowest discharge rate values in similar periods of time
$\dot{V}_L$	m³/s	Lowest value of the discharge rate in a period of time
$\dot{V}_{LL}$	m³/s	Lowest recorded discharge rate
$\dot{V}_{Dpot}$	m³/s	Potential runoff rate
$\dot{V}_{D\Delta t}$	m³/s	Discharge rate in the time interval Δt

Table 4 (continued)

Formula symbol	Units	Parameter/term
$\dot{V}_{Dact}$	m^3/s	Actual runoff rate
$\dot{V}_{Dl}$	m^3/s	Discharge loss rate
$\dot{V}_{wint}$	m^3/s	Water intrusion rate
$\dot{V}_{D0}$	m^3/s	Discharge (at the initial measurement)
$\dot{V}_{D0}$	m^3/s	Discharge rate at the time t_0
v_{Da}	m/s	Darcy velocity
v_{dist}	m/s	Distance velocity
v_{flow}	m/s	Flow velocity
v_{true}	m/s	True groundwater velocity
v_{fl}	m/s	(Characteristic) flow velocity of the fluid
v_m	m/s	Mean permissible flow velocity in the filter gravel
v_{max}	m/s	Maximum water entrance velocity in the well
W	$100\% = 1$	Water content
W_{pl}	mm/a	Plant-available water quantity
$W(u)$	1	Theis well function
$w(X)$	$kg/kg = 1$	Mass ratio = mass of solute X in kg per kg of solution
X	$mm/(d \cdot hPa)$	Monthly coefficient (Haude) (Pa = Pascal (pressure))
x, x_1, x_2	m	Coordinates
x_1	$\sqrt{\frac{s}{m}}$	$= 15\sqrt{\frac{s}{m}}$, empirical coefficient according to Sichardt
x_2	$s \cdot mm/m$	Empirical coefficient for the borehole diameter
Z	1	Equivalent number (e.g., valency of an ion)
α (alpha)	$1/d$	Spring-specific coefficient, Drainage coefficient
α	$1/hPa$	Bunsen absorption coefficient (temperature-dependent), solubility coefficient
α_L	$1/s$	$= k_f/l$, Leakage coefficient
α_{diss}	1	Degree of dissociation
β (beta)	1	Damping coefficient
$\beta(X)$	g/l mg/l kg/m^3	Mass concentration
γ (gamma)	K^{-1}	Volume expansion coefficient
ΔA_{cb}	km^2	Area of the sub-catchment basin
ΔG	J/mol	Difference in the free enthalpies of the individual reaction partners
ΔH_S	J/g	Melting enthalpy
ΔH_V	J/g	Enthalpy of evaporation
ΔS	$J/(mol \cdot K)$	Difference in the molar entropies of the individual reaction partners
ΔU	J/mol	Difference in the molar bond energies of the individual reaction partners
ΔV	m^3	Changes in groundwater storage
ΔV_m	m^3/mol	Change in volume
$\Delta \dot{V}_D$	l/s	Partial-discharge rate
Δh	m	Difference in the groundwater level, difference in groundwater level
Δh_{gw}	m	Change in the hydraulic head (drawdown of the groundwater level)
$\Delta \dot{h}_D$	$l/(s \cdot km^2)$	Partial-specific yield
Δp	Pa	Pressure difference
Δs_a	m	Distance between two flow lines
$\delta^2 H$	$1000‰ = 1$	Relative difference of the hydrogen isotope ratio of a sample related to that of a standard
$\delta^{18}O$	$1000‰ = 1$	Relative difference of the oxygen isotope ratio of a sample relative to that of a standard
ε (epsilon)	$1/min$	Natermann parameter
ε	1	Dielectric constant
η (eta)	$Pa \cdot s = kg/(s \cdot m)$	Dynamic viscosity (Pa = Pascal (pressure))

(continued)

Table 4 (continued)

Formula symbol	Units	Parameter/term
Θ (theta)	$100\% = 1$	Degree of water saturation $= V_w/V_p$
ϑ (theta)	°C (Celsius)	Celsius temperature (difference in temperature $1\ °C = 1\ K$)
ϑ_{airmom}	°C	Monthly mean of the air temperature
ϑ_{14}	°C	Air temperature at 14:00 o'clock
ϑ_w	°C	Water temperature
ϑ_{boil}	°C	Boiling temperature
ϑ_{10}	°C	Constant $= 10\ °C$ for the determination of the drought index
ϑ_F	°F	Fahrenheit temperature
ϑ_R	°R	Réaumur temperature $1\ °R = 1.25\ K = 1.25\ °C$
K (kappa)	1	Equilibrium constant of a reaction
κ (kappa)	S/m	Electrical conductivity, $= 1/_{el}$
Λ_M (lambda)	S·cm^2/g	(Specific) equivalent conductivity
Λ	S·cm^2/mol	Molar equivalent conductivity
λ	nm	Wavelength
λ	W/(K·m)	Thermal conductivity (W = Watt (power)) (K = Kelvin (absolute temperature))
λ_A	1/a	Decay constant
ν (ny)	m^3/kg	Specific volume $\nu = 1/\varphi$
ν_{fl}	m^2/s	Kinematic viscosity $= \eta/\rho$ of a fluid
ν_w	m^2/s	Kinematic viscosity of water
ρ (rho)	kg/m^3	Density $= m/V$
ρ_{so}	g/cm^3	Density of the solid material
ρ_{fl}	kg/m^3	Density of the fluid
ρ_{bulk}	kg/m^3, g/cm^3	Bulk density of the sediment
ρ_w	10^3 kg/m^3	Density of water (at ... °C)
ρ_{el}	$\Omega \cdot m$	Specific electrical resistance $\rho_{el} = \frac{1}{\kappa}$ (Ω = Ohm (electrical resistance))
Σ (sigma)		Sum
σ (sigma)	N/m	Surface tension (N = Newton (force))
σ	kg/(m^3·s)	External source and/or sink term
τ (tau)	1	(Light flux) transmittance
φ_{14} (phi)	$100\% = 1$	Relative air humidity at 2
φ_{mom}	$100\% = 1$	Monthly mean of the relative air humidity
φ_e	lm (Lumen)	Incoming light flux
φ_{tr}	lm	Transmitted light flux
χ (chi)	1	Fraction of the bank infiltrate in the mixed groundwater
$\chi\left(\frac{1}{z}X\right)$	$100\% = 1$	Molar ratios of the equivalents
χ	m^2/N $= 1$/Pa	Compressibility $= 1/E$ (Pa = Pascal (pressure)) (N = Newton (force))
χ_{so}	m^2/N	Compressibility of the porous medium (solid material)
χ_w	m^2/N	Compressibility of water $= 4.8 \cdot 10^{-10}$ m²/N
Ψ_m (psi)	hPa	Matrix potential (suction tension, soil moisture tension)/vacuum (Pa = Pascal (pressure))
∇	1/m	Nabla operator