Nährstoffamagement für Schwimmteiche und Naturpools

Nutrient-Management in Natural Swimming Ponds and Pools

Wolfgang Wesner

Franz Kubacek

define clean

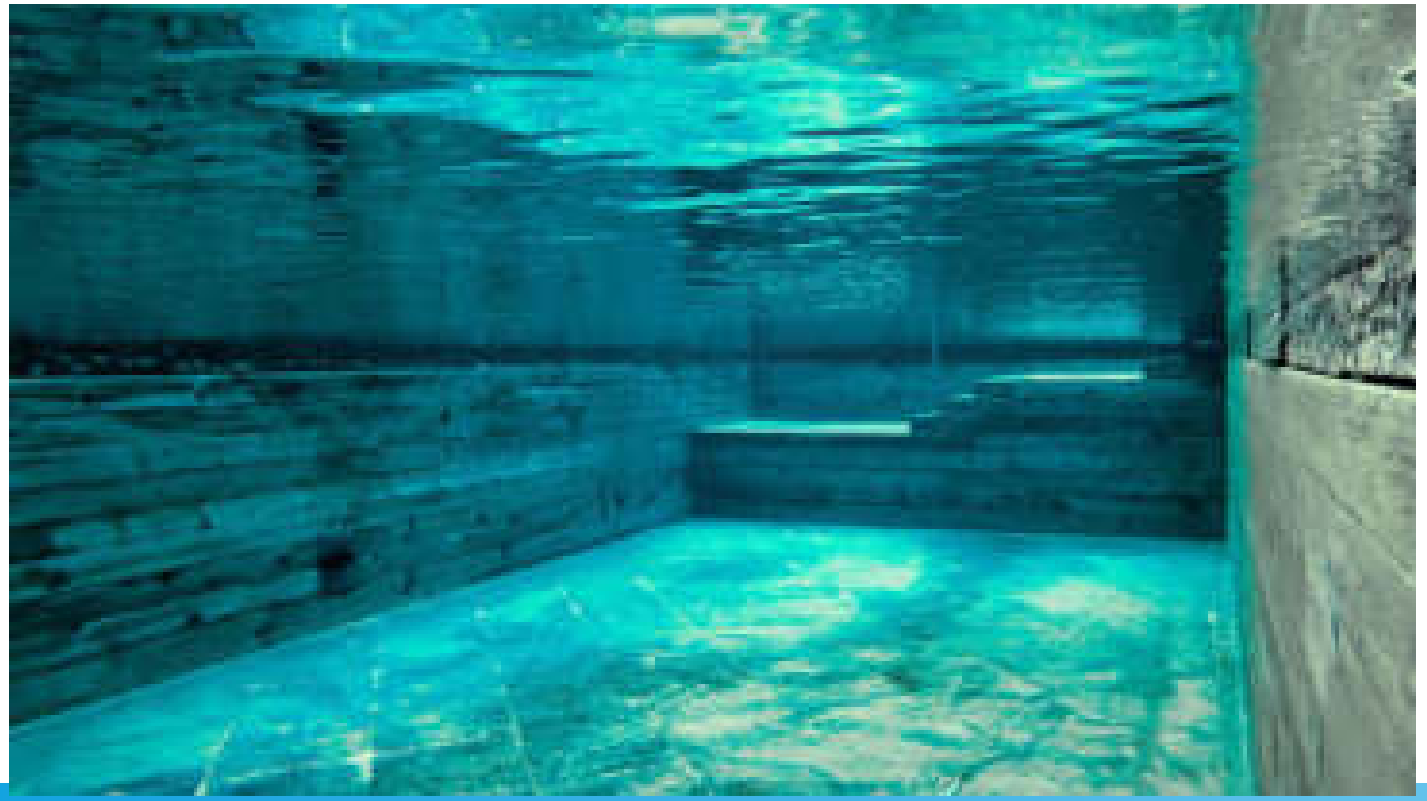
Saubere Pools

Clean Ponds and Pools

define clean

Kristallklares Wasser

Cristall Clear Water



define clean

Klares Wasser = sauberer Pool ?

- keine Algen
- keine Schwebalgen
- keine Beläge
- keine Verfärbungen
- kein Geruch
- kein Gift
- die nasse Wüste...

clean water = clean pool ?

- no algae
- no phyto plankton
- no biofilm
- no color
- no smell
- no poison

….the wet desert,

define clean

Wie geht das?

How is this possible?

define clean

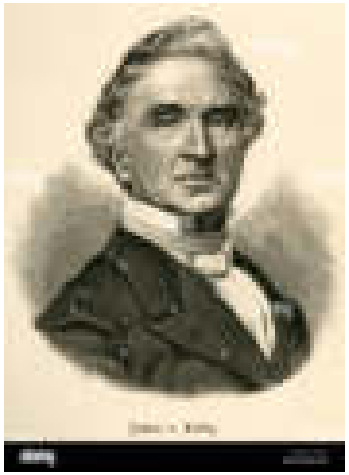
Viele Faktoren ausschlaggebend	Many factors are crucial
• Bauweisen	Construction Methods
• Materialien	Materials
• funktionierende Filter	Filters which are functional
• Teichrand Gestaltung	Construction of pond edge
• usw.	etc.
UND	AND

Principle of the minimum

Limitierung nach Liebig

! one missing Element limits the growth !

which Element?

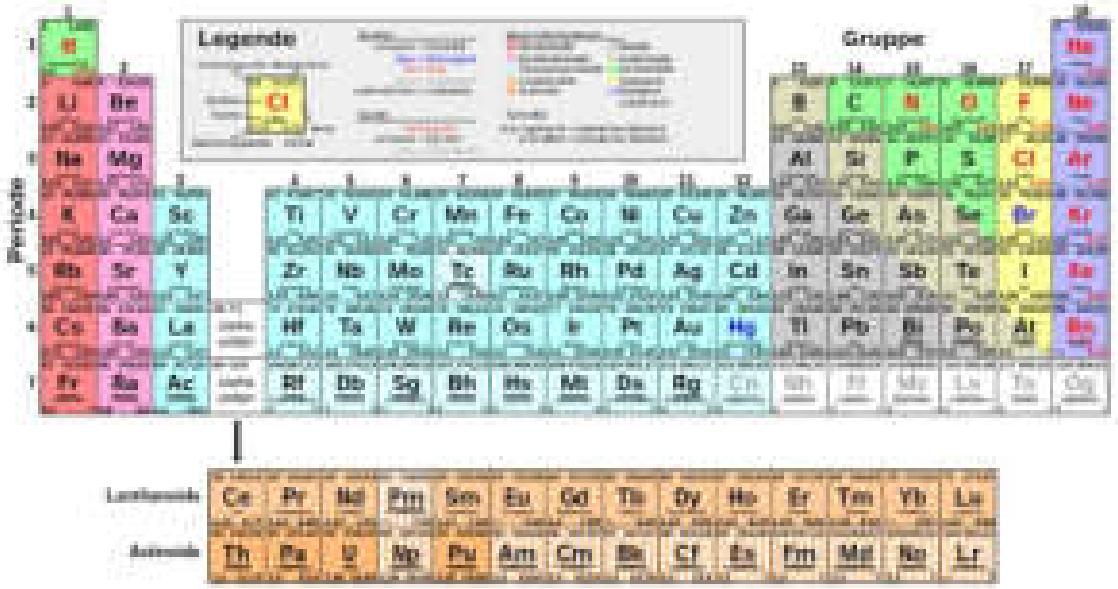


your choice..

Principle of the minimum

! one missing Element limits the growth !

Choice of the limiting Element



your choice..?

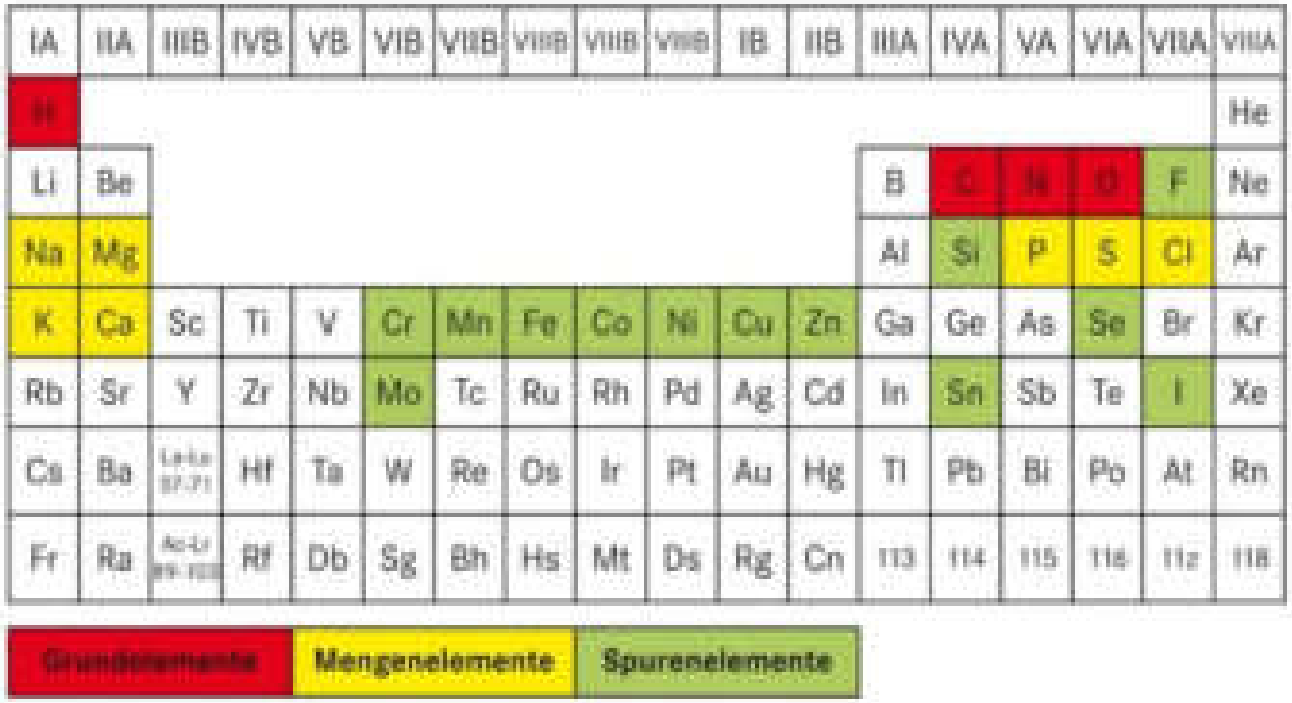
are you able to realize your choice?

Principle of the minimum

! one missing Element limits the growth !

Choice of the limiting Element

23 essential Elements for life



H Wasserstoff 60,3%
O Sauerstoff 25,5%
C Kohlenstoff 10,5%
N Stickstoff 2,42%
Na Natrium 0,73%
Ca Calcium 0,226%
P Phosphor 0,134%
S Schwefel 0,041%
K Kalium 0,036%
Cl Chlor 0,032%
Mg Magnesium 0,010%
Fe Eisen, Cr Chrom, Co Kobalt, Cu Kupfer, Mn Mangan, Mo Molybdän, Sn Zinn, Zn Zink, F Fluor, I Iod, Se Selen, Si Silicium

Principle of the minimum

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Choice of the limiting Element

23 essential Elements for life

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Choice of the limiting Element

23 essential Elements for life

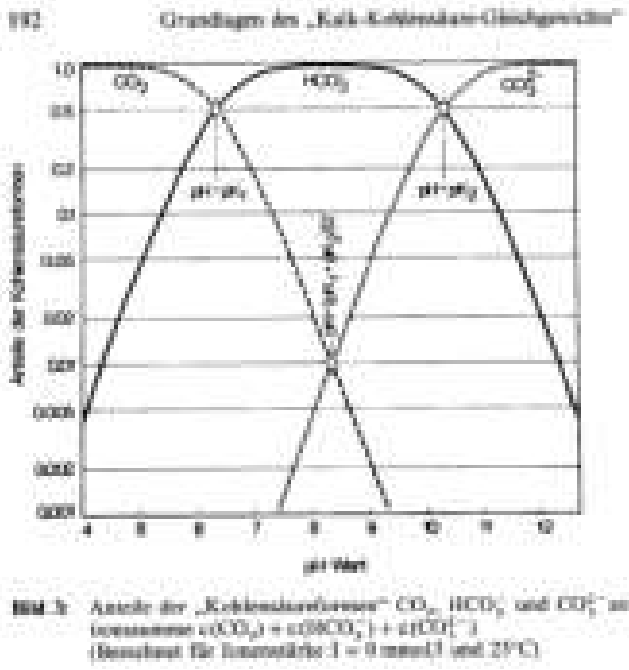
Limitation of C ?

partly possible, used for Koi-pond

use HCl → pH < 7

- limits algae
limits dissolved CO2
limits photosynthesis

- does not limit bacteria, biofilm
- no lime gravel possible!



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Principle of the minimum

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Limitation of N ?

works for

limitation of algae
limitation of biofilm and bacteria

!!! does not work for Cyanobacteria !!!
(blue-green algae use N2 from air!)

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Principle of the minimum

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Choice of the limiting Element

23 essential Elements for life

Limitation of Na ?

maybe? Nobody did….

- Na is very soluble, not easy to limit
- sweat contains Na
- avoid Humans

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Principle of the minimum

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Choice of the limiting Element

23 essential Elements for life

Limitation of Ca ?

maybe? Nobody did….

- Ca is omnipresent, not easy to limit

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Principle of the minimum

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Choice of the limiting Element

23 essential Elements for life

Limitation of P ?

Bingo

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Principle of the minimum

! one missing Element limits the growth !

Limit P

no life without P

P is quite rare in environment

PO_4^{3-} can be bound on Fe, Ca, Al

PO_4^{3-} is bound by biofilm

Principle of the minimum

! one missing Element limits the growth !

….our choice is to Limit P

how can we do so?

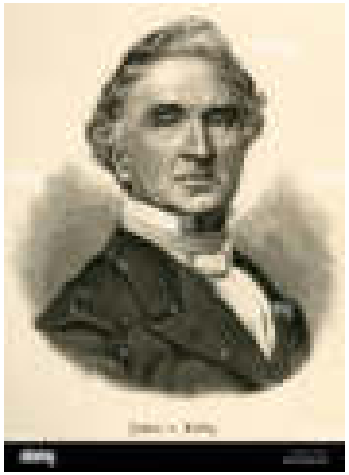
- **avoid P-rich building materials**
- **avoid input from environment**
- **bind P by growing biofilm**

Principle of the minimum

Limitierung nach Liebig

! one missing Element limits the growth !

which Element?



your choice..

Principle of the minimum

! one missing Element limits the growth !

….our choice is to Limit P

!! you have to ensure that all other Elements are in excess !!

→ you get a P- Limitation

if just one concentration is to low you get an unfavorable limitation

- eg. N → blue-green algae (Cyanobacteria)
- → management of nutriments is important!

Limit P

limitierendes Element P

- Limitierung von Algenwachstum / limit for algae growth
  P <10 µg/l
- Limitierung von Biofilmwachstum / limit for biofilm
  P <4 µg/l

Alle anderen Nährstoffe dürfen nicht limitiert sein damit der Biofilm bereit ist für die P Aufnahme (Düngung).
/
All other nutriments have to be available for the biofilm in the filter (Management).

Redfield-ratio / Redfield Verhältnis

Anteile der atomaren Zusammensetzung vom maritimen Phytoplankton. Das 1963 von Redfield, Ketchum und Richards empirisch gefundene und veröffentlichte Verhältnis ist:

1 Mol P: 16 Mol N: 106 Mol C

this ratio gives a hint for the requirement of nutriments. For one P you need 16 N and 106 C to build up biomass.

If you do not deliver 16 times N and 106 times C you can not bind P in biomass!

calculating with Redfield-ratio

$C_{106}H_{263}O_{110}N_{16}P_1$ = 3550 g/mol

1 Kg Phosphor: 32,26 mol ·
3550 g/mol= 114‘516 g = **114,5 Kg Trockensubstanz /dry biomass!**

Due to Redfield if you put in 1 Kg P you can grow 114,5 Kg Biomasse
(dry biomass / Trockensubstanz!!)

living cells contain about 90 % H2O => **1000 kg biomass (blgae or biofilm)**

1 g Phosphoranteil ergibt ca. 1000 g Biomasse

calculating with Redfield-ratio

$C_{106}H_{263}O_{110}N_{16}P_1$ = 3550 g/mol

1 kg Phosphor: 32,26 mol ·
3550 g/mol P = 114‘516 g = **114,5 Kg Trockensubstanz /dry biomass!**

to get rid of 1kg pure P by growing 1000kg biofilm

you have to add 32x16 mol N = 32x16x14 = 7168g = 7,168kg N

you have to add 32x106 mol C = 32x106x12 = 40,7 kg C

really? no….

Nature delivers the major part if the dirt is natural….

….but if the input is P – fertilizer, P from building material, P without C and N…

C can be grown in the pond by photosynthesis → plants, algae

WAS HEISST DAS JETZT?

WHAT WILL THIS MEAN?

Wir müssen darauf achten, dass außer Phosphor alle Nährstoffe ausreichend vorhanden sind

We have to make sure that all nutrients except phosphorus are sufficiently present

WELCHE NÄHRSTOFFE SIND BESONDERS WICHTIG?

WHICH NUTRIENTS ARE IMPORTED FOR US?

PHOSPHOR PHOSPHORUS

< 10 µg/l in type 4 and 5

< 30 µg/l in type 1-3

WELCHE NÄHRSTOFFE SIND BESONDERS WICHTIG?

WHICH NUTRIENTS ARE IMPORTED FOR US?

NITRAT NITRATE

1 – 25 mg/l

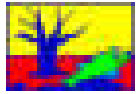
Was muss vermieden werden?

Avoid!

NITRIT NITRITE

< 0,05 mg/l

Ammonia or Nitrate may form Nitrite!
- never apply too much Nitrogen!
-avoid lack of Oxygen



Sehr giftig für Wasserorganismen. Wassergefährdend (WGK 3)

Was muss vermieden werden?

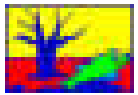
Avoid!

SULFAT

SULPHATE SO_4^{2-}

< 40 mg/l

Biofilm converts Sulfate to H_2S !



Sehr giftig für Wasserorganismen. Wassergefährdend (WGK 2)

Schwefelwasserstoff ist ein starkes Gif das auch den Biofilm abtötet und so die Aufnahme von P verhindert.

WIE GARANTIEREN WIR DIE RICHTIGE VERSORGUNG?

HOW IS IT POSSIBLE TO HAVE ALL IMPORTEND NUTRIENTS?

Es gibt zahlreiche Mittel am Markt, die eine gute Zusammensetzung von in Mangel kommenden Nährstoffen sowie Spurenelementen aufweisen

There are a lot of products in the market which have importend nutrients and micro elements

WEITERE WICHTIGE PARAMETER

OTHER IMPORTEND PARAMETER

WASSERHÄRTE	HARDNESS
7 – 14 dH	
Härte bis 20°stellt kein Problem dar. Umso höher die Härte, umso leichter lassen sich Beläge entfernen	Hardness up to 20°is no problem. The higher the hardness, the easier it is to remove organic plaque

WEITERE WICHTIGE PARAMETER

OTHER IMPORTEND PARAMETER

pH-Wert	PH value
8,3 – 8,4	
im Mittel	on average
Schwankt der pH-Wert im Tagesverlauf zu stark, ist die Härte zu gering oder die Anlage ist stark veralgt	If the pH value fluctuates to much over the course of the day, the hardness is too low or the system is heavily contaminated with algea

ZUSAMMENFASSUNG

RESUME

wenige wichtige Werte	few important value
Nitrat	Nitrate
Härte	Heardness
Sulfat	Sulphate
Phosphor	Phosphorus

Possible?

Klares Wasser = sauberer Pool ?

- keine Algen
- keine Schwebalgen
- keine Beläge
- keine Verfärbungen
- kein Geruch
- kein Gift
- die nasse Wüste...

clean water = clean pool ?

- no algae
- no phyto plankton
- no biofilm
- no color
- no smell
- no poison

….the wet desert,

Yes

ein wichtiger Punkt:

an important point

Närstoffmanagement

Nutrient Management


FRAGEN ? QUESTIONS

WIR DANKEN FÜR EURE AUFMERKSAMKEIT UND WÜNSCHEN EUCH VIELE SCHÖNE PROJEKTE MIT OPTIMALEN WASSERWERTEN

WE THANK YOU FOR YOUR ATTENTION AND WE WISH YOU MANY BEAUTIFUL PROJECTS WITH OPTIMAL WATER VALUES