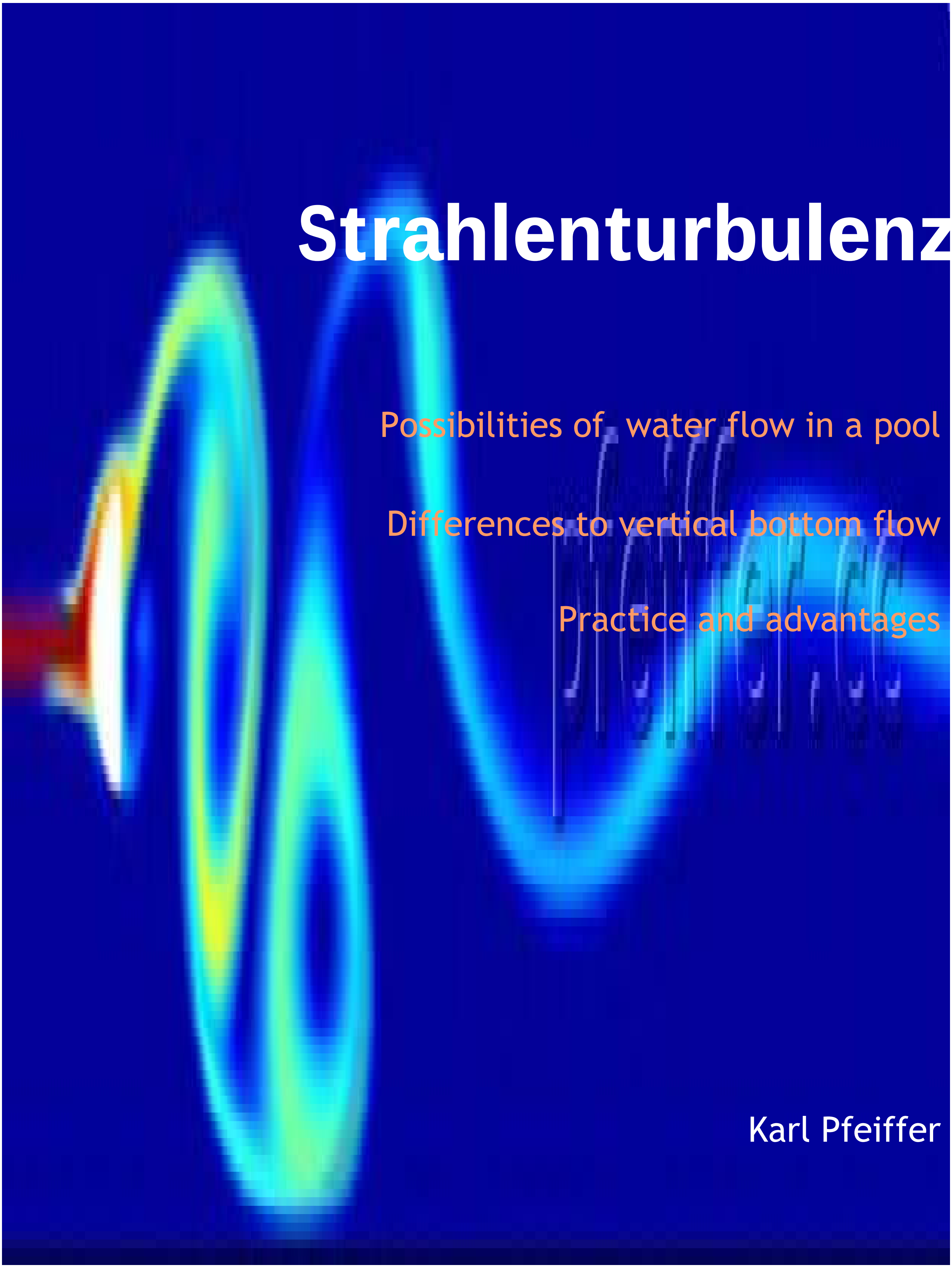

Strahlenturbulenz

Possibilities of water flow in a pool

Differences to vertical bottom flow

Practice and advantages

Karl Pfeiffer

PfeifferPartner is known as the independent and objective specialists and experts in planing Hot Spring Spas, Water Parks and commercial recreation and wellness

PfeifferPartner works within EC and internationally in project development, planing, realization and operation of all ranges and types of water leisure plants.

From Green Field Projects of Hot Spring Spas, full-year-spas or summer-spas to the revitalization of public or hotel spa`s.

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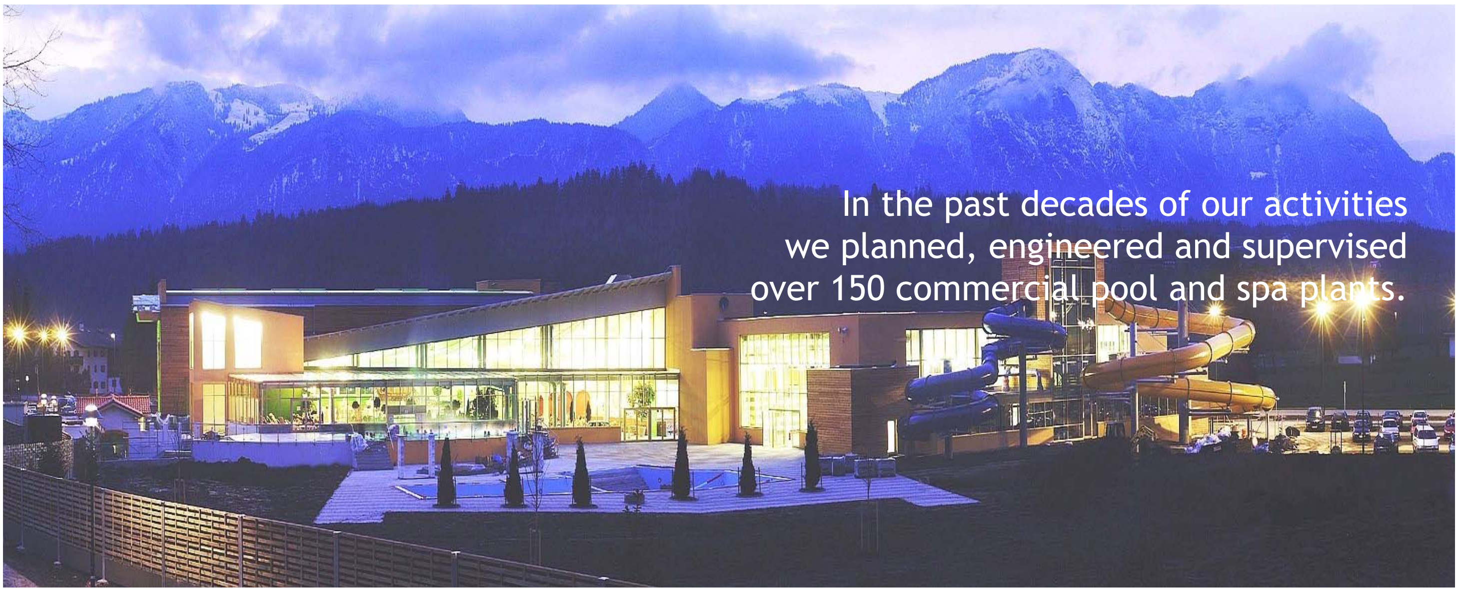

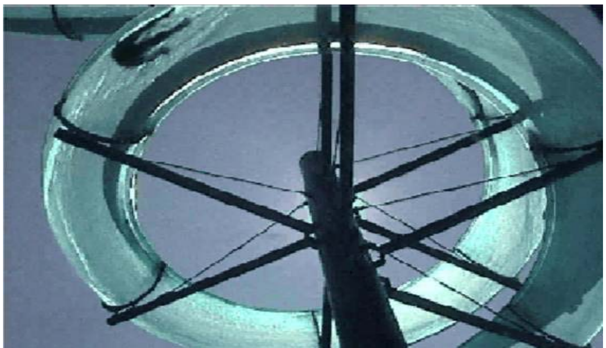

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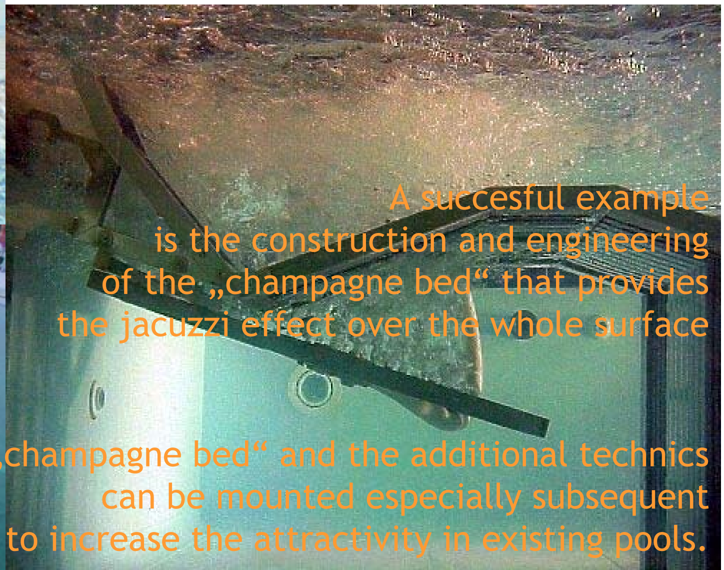
Since I did my first pool in 1988
a lot has changed in the technologies
of pool systems and water treatment.

Today it`s not enough to serve the guests
with huge water areas, warm and clear water.

We designed attractions as
the beach with rolling waves,
and the „wave behind glass“, that
have been approved and often repeated.



A succesful example
is the construction and engineering
of the „champagne bed“ that provides
the jacuzzi effect over the whole surface

The „champagne bed“ and the additional technics
can be mounted especially subsequent
to increase the attractivity in existing pools.

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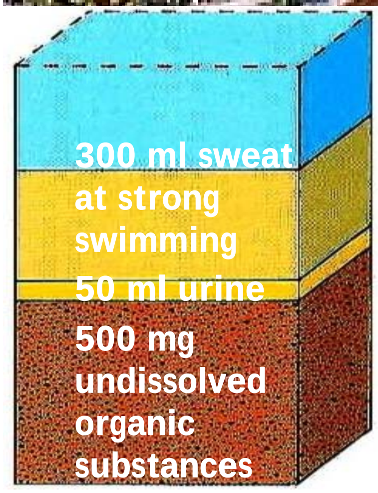

The input consists of various particles and dissolved matters.
The removing of these undesired substances needs various proceedures :

Mechanical Particles Sand, Dust, Hair, Dandruffs, Plant Particles	fine - middle granular 100 µm [0,1mm] - 5 mm	Hair + Fibre Prefilters Sedimentation, Filtration
Undissolved Suspensed Dust, Spores, Pollen, Skin particles, Plant Particles	Coarse dispersed „molecular lumps“ 0,5 µm [0,0005mm] - 100 µm	Filtration with or without Flocculation Sand, Hydrocarbon,...
Colloides Spits, Slime, Fats, Oils, humine acids, precipitates..	Fine Dispersed „molecular lumps / threads“ 0,01 µm [0,00001mm] - 1µm	Flocculation + Filtration Adsorption Siliceous earth / Diatomeen
Dissolved Matters urea, sweat, Chloride, Nitrate, Phosphate, Iron, Gases, ..	Ions, Molecules bis 0,01 µm [0,00001mm]	Dilluting, Oxidation, Adsorption Activated Carbon

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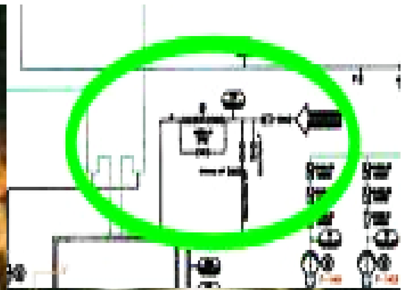
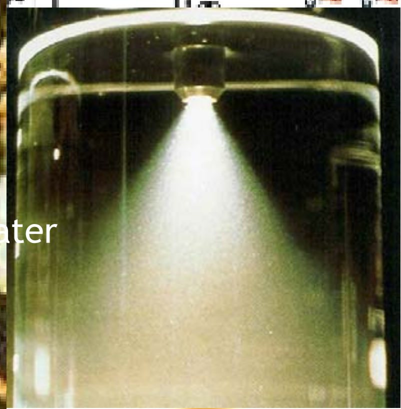
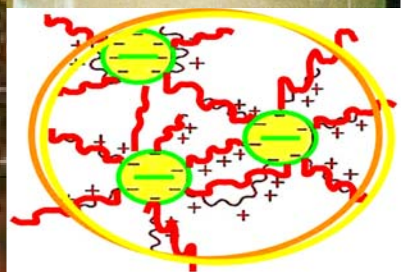
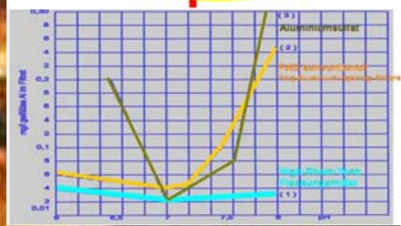


\ Targets in pool water treatment

- Minimizing of input substances
  - \ Providing the necessary amount of fresh water
- Maximizing of Output of non-desired substances
  - \ Flocculation + Filtration
- Elimination of input substances and reaction products
  - \ Optimum flow systems to renew the pool water

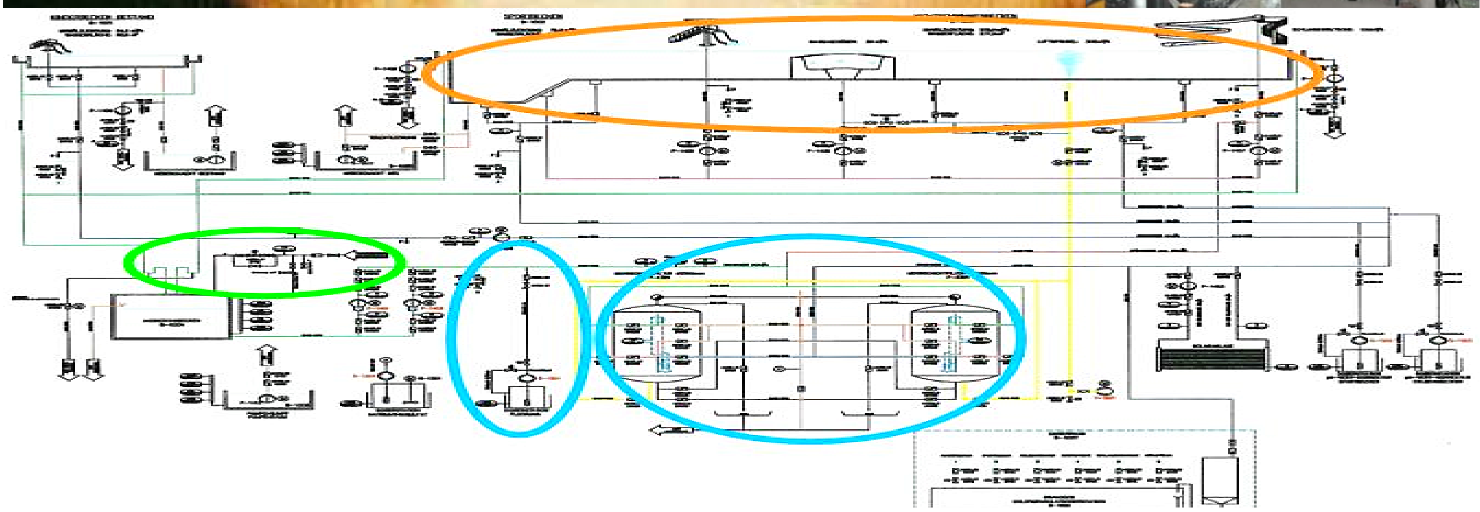






In summary this means the need of

\ Optimal Reaction Conditions



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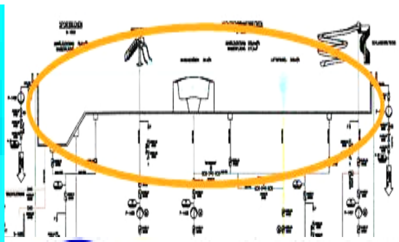
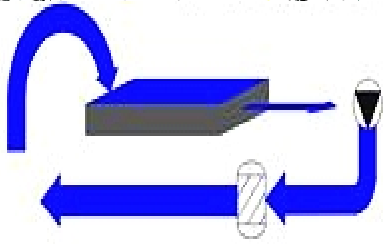
\ **Only an optimum flow system can maintain the renewal of pool water within shortest times and over the whole surface.**

\ **The right capacity has to be calculated according to several dimension parameters.**





N = Persons /h

A = Pool Area [m²]

a = pool surface / person [1/m²]

k = treatment depending factor [1/m³]

$$N = \frac{A \times n}{a}$$

$$Q_{1-n} = \frac{N_{1-n}}{k} = \frac{A_{1-n} \times n}{a_{1-n} \times k} = [m^3/h]$$

Beckenart	Wassertiefe [m]	Wasserfläche je Person a [m²]	Nennbelastung N [1/h]	Volumenstrom Q [m³/h]
Schwimmerbecken	>1,35	4,5	$\frac{0,222}{m^2 \times h} \times A$	$\frac{0,222}{m^2 \times h} \times \frac{A}{k}$
Nichtschwimmerbecken	0,6 – 1,35	2,7	$\frac{0,37}{m^2 \times h} \times A$	$\frac{0,37}{m^2 \times h} \times \frac{A}{k}$
Warmsprudelbecken (begrenzte Nutzung)	≤ 1,0	1 Sitzplatz	$\frac{3}{h} \times P$	$\frac{15}{h} \times V$
Warmsprudelbecken (kombinierte Nutzung) eigene Aufbereitung	≤ 1,0	---	$\frac{20}{h} \times k \times V$	$\frac{20}{h} \times V$
Warmsprudelbecken (kombinierte Nutzung) angeschlossene Aufbe-reitung	≤ 1,0		$\frac{10}{h} \times k \times V$	$\frac{10}{h} \times V$
Therapiebecken	≤ 1,35	4	$\frac{1}{h} \times k \times V$	$\frac{1}{h} \times A$

Example Kombi-Pool 25 x 10 m with 2 zones:

1. Non swimming [D<1,35M] 10 x 10 m = 100 m²
2. swimming [D>1,35M] 15 x 10 m = 150 m²

Capacity acc. to DIN 19643:

$$Q_1 = \frac{N_1}{k} = \frac{A_1 \times n}{a_1 \times k} = \frac{100 \times 1}{2,7 \times 0,5} = 74\ m^3/h$$

$$N_1 = \frac{A_1 \times n}{a_1} = \frac{100 \times 1}{2,7} = 37\ h^{-1}$$

A_1 = 100 m²
n = 1/h
a_1 = 2,7 m²
k = 0,5 m^{-3}

$$Q_2 = \frac{N_2}{k} = \frac{A_2 \times n}{a_2 \times k} = \frac{150 \times 1}{4,5 \times 0,5} = 67\ m^3/h$$

$$N_2 = \frac{A_2 \times n}{a_2} = \frac{150 \times 1}{4,5} = 33\ h^{-1}$$

A_2 = 150 m²
n = 1/h
a_2 = 4,5 m²
k = 0,5 m^{-3}

Total capacity according to DIN 19643 is: $Q = Q_1 + Q_2$ = 74 m³/h + 67 m³/h = 141 m³/h

$N = N_1 + N_2$ = 37 h^{-1} + 33 h^{-1} = 70 h^{-1} Persons per Hour

E.g.: When the circulation is kept for 24 hours, 1.680 guests per day may use the pool.

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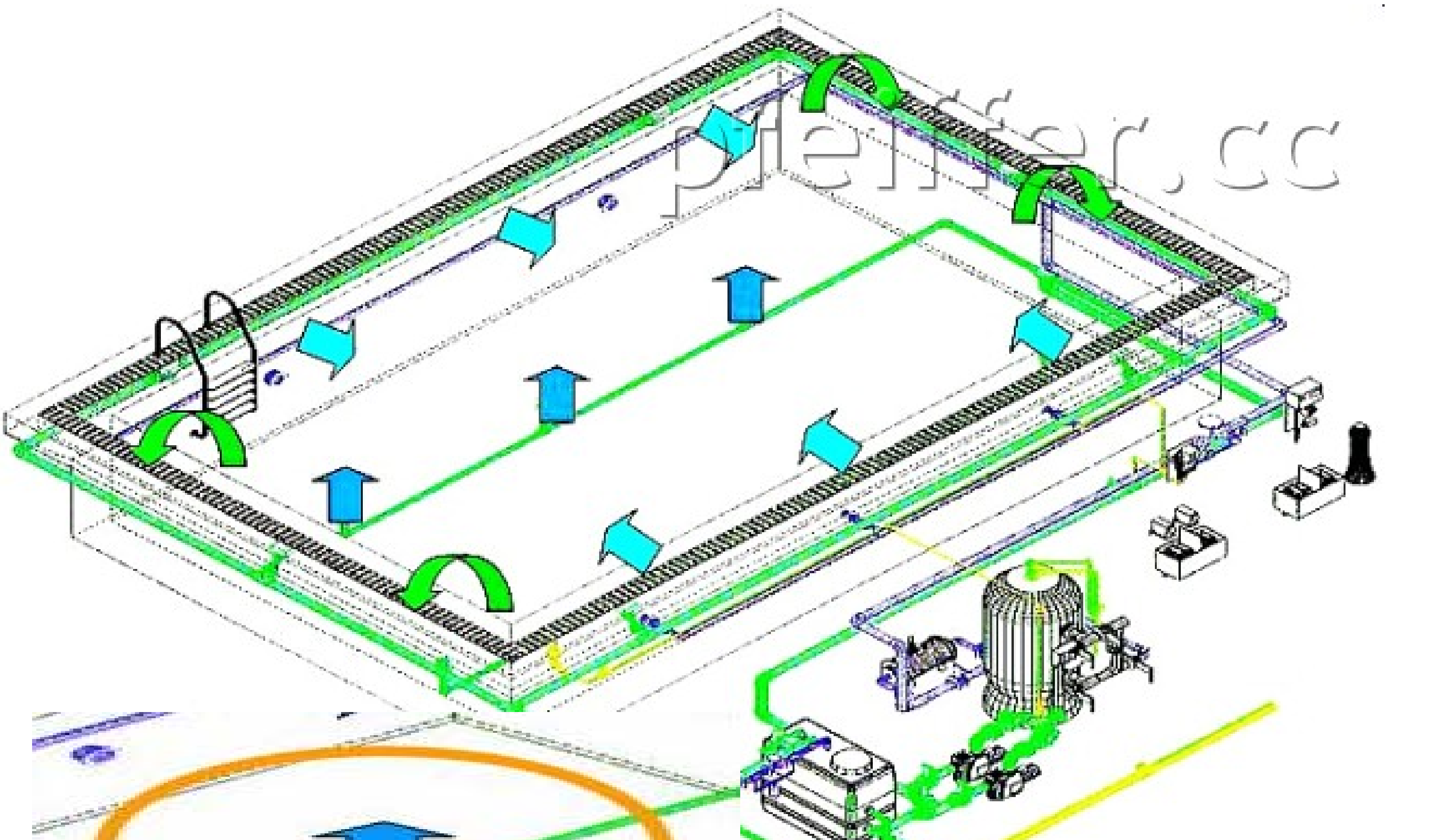
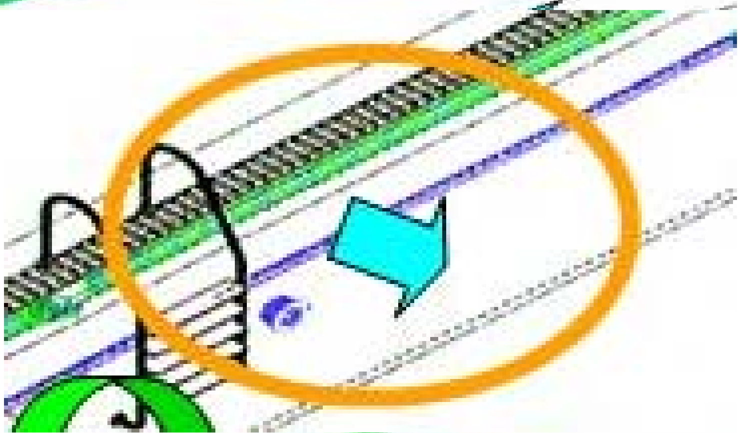
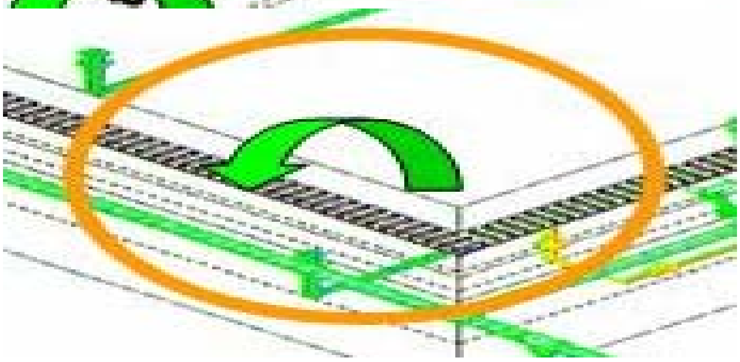
Generally there are two possibilities
to maintain circulation through the pool







Vertical bottom flow

Depth > 1,35 M : 1 Nozzle per 8 m^2
Depth < 1,35 M : 1 Nozzle per 6 m^2
Non affected area: Max 4 m^2 (3 m^2)
Bottom channels: Max Distance 3,2 m

Horizontal flow

Nozzle distance = e = 0,3 x B + z [m]
Nozzle position depends on geometry
Border distance = a = 0,5 to 0,75 m
Pressure = h = (mWS)
Installation height = t
t = -½ D (D<1,35 m)
t=-1,50 m (D up to 2,0 m)
t = -1,50 m and –3,30 m (D=3,80 m)

Always with an overflow

gutter round the pool
$Vv = e^{0,0501qw}$

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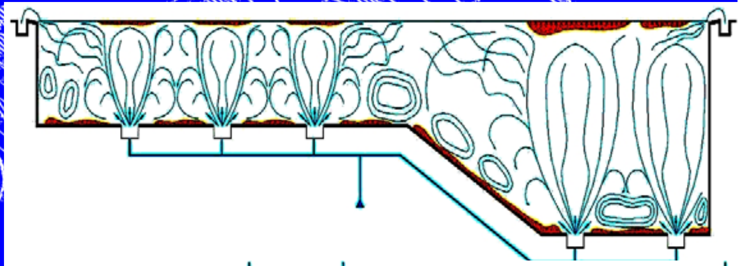
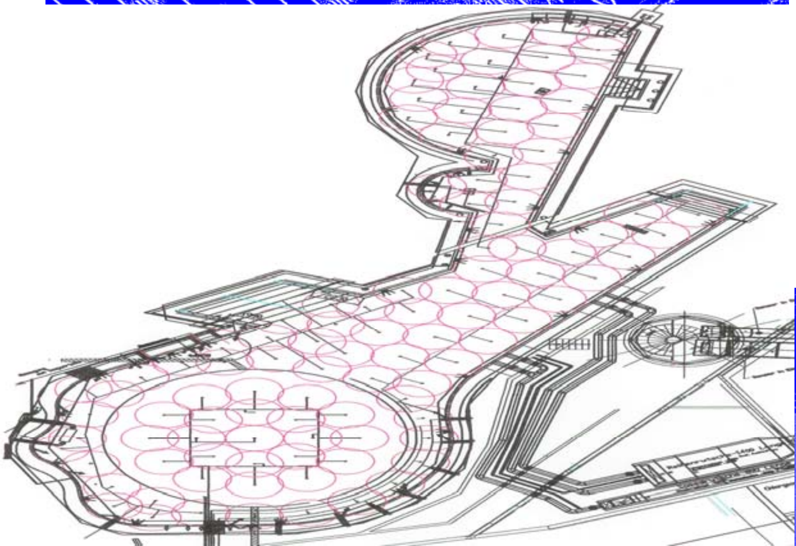
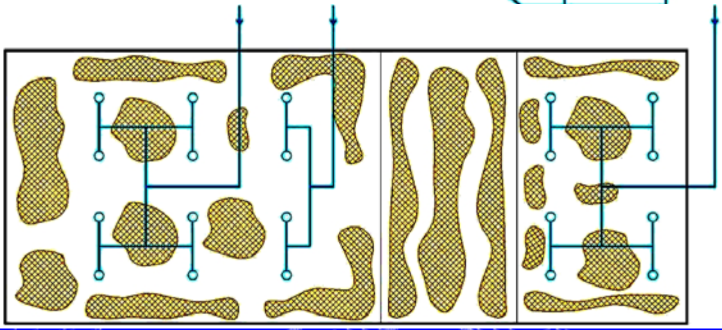
\ Vertical bottom flow

ertical bottom flow is obtained by dividing the area through maximum possible flow rates

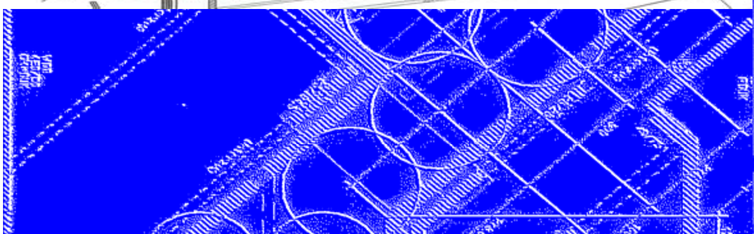
Depth > 1,35 M : 1 Nozzle per 8 m^2
Depth < 1,35 M : 1 Nozzle per 6 m^2
Non affected area: Max 4 m^2 (3 m^2)
Bottom channels: Max Distance 3,2 m

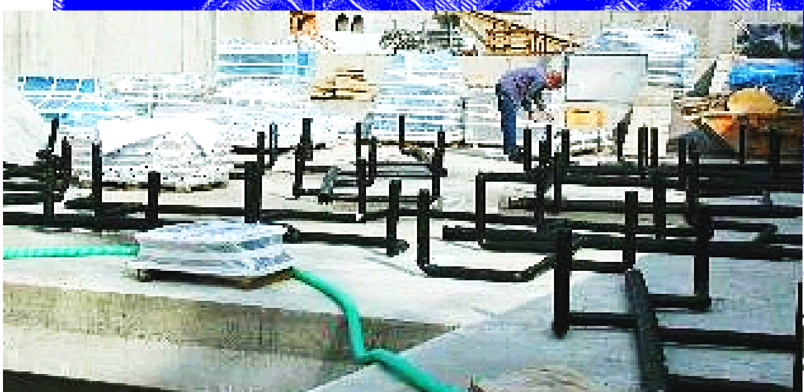




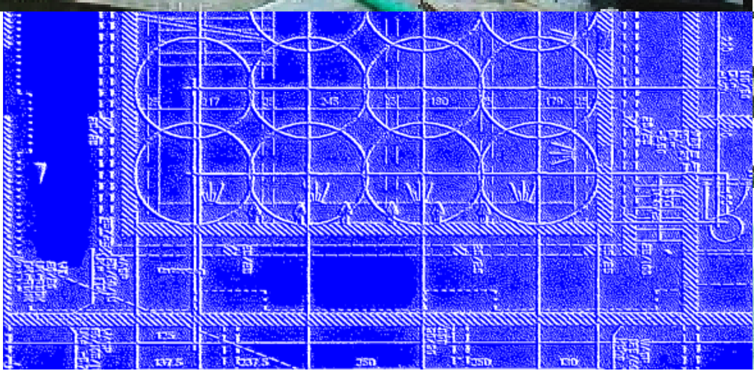


This means a lot of dimensioning works for collecting, sub-collecting, sub-sub-collecting a.s.o. - pipes.





And the single-and-each nozzle-system means a tremendous afford in piping within the concrete bottom layer



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\ Vertical bottom flow

Engineering and prefebrication of bottom pipings
may be handled by your experianced and skilled workers.

\ The real problems start when
the realization of your works will meet to others on site.

Sorry, You`ve mounted the bottom frame in world record time, but concrete layer will be delayed for about 5 days..

Thank you for being so fast with bottom piping > Now we have to wait 4 weeks for drying ....because of the tile terms...

Coordinating with the coating company is still not possible, because the payment has not been assured yet..

Unfortunately the ironing-reinforcment-company has to do more important works at the sauna pool...now yet..

A lot of work
- that will not be paid -
has to be done
-until your success
will be part of the summary
success of the project...

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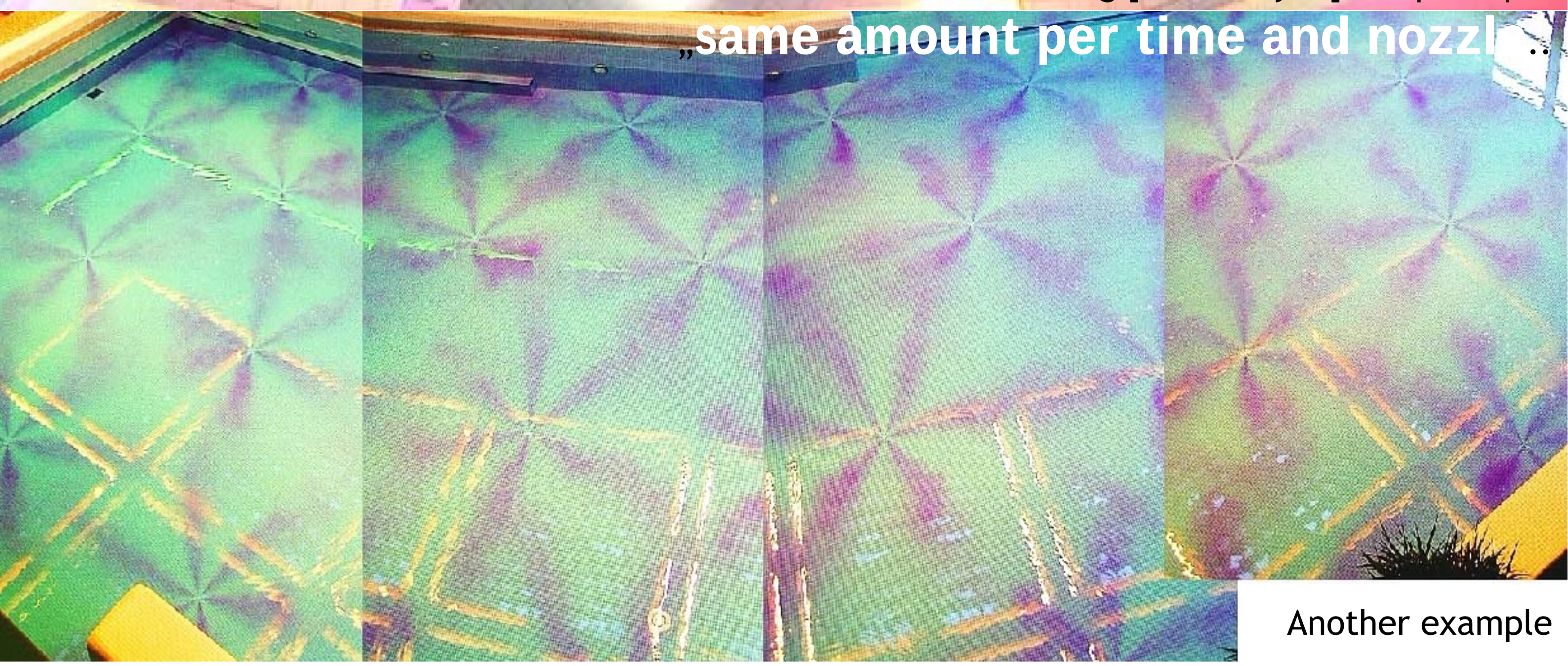
\ Bottom flow \ Effects

The **dying test** shows the results of all the engineering, piping works, coordinations, possible conflicts and mounting affords

Laminar flow at bottom nozzles

Follwing [not always..] the principle

„same amount per time and nozzle"



Another example

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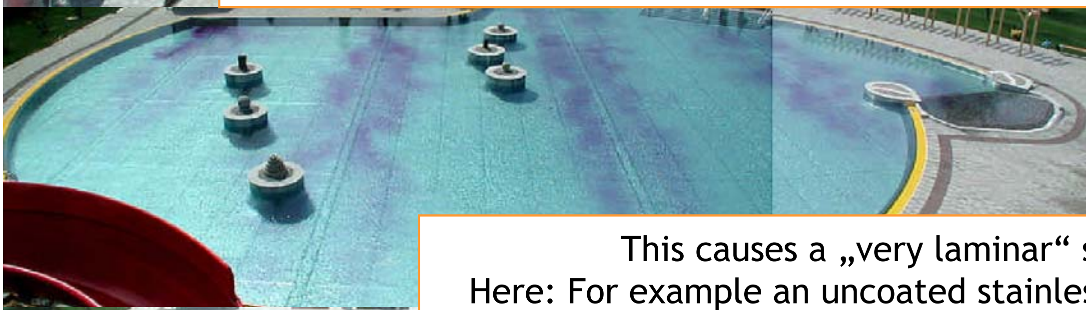
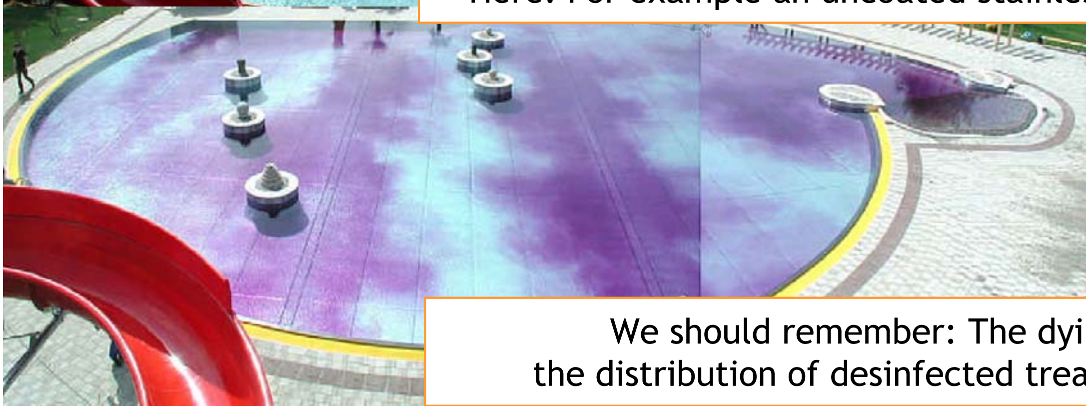
\ Bottom flow \ Effects

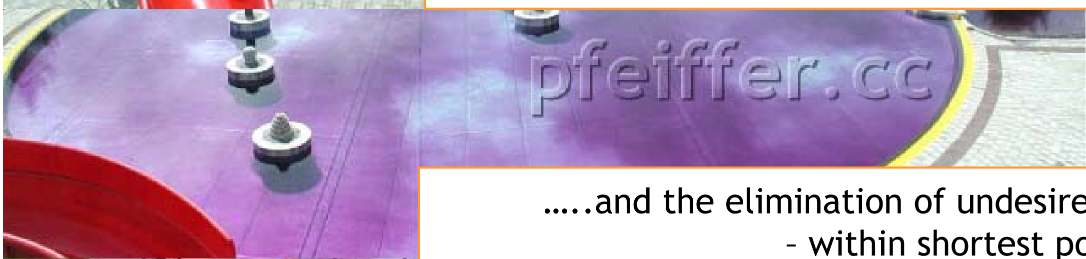
In contrast to bottom nozzles bottom channels are at least only „covered pipes“ with only one inlet and punched inlet openings.



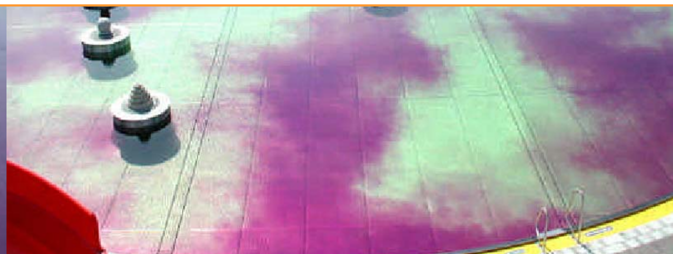
This causes a „very laminar“ streaming in.
Here: For example an uncoated stainless steel pool.



We should remember: The dying test shows the distribution of desinfected treated water…..



…..and the elimination of undesired substances – within shortest possible time..

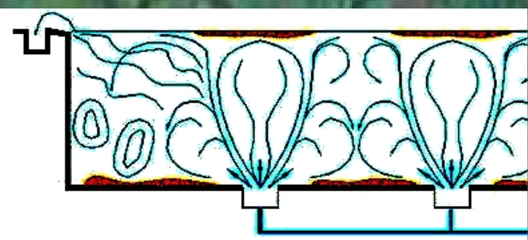


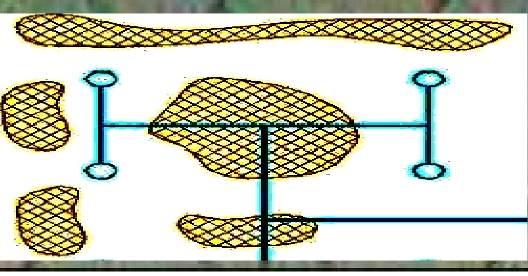
Finally the deinking test shows the remaining weak zones (…that will remain for the next 30 years...)

\ Summary \ bottom flow

- Traditionally accepted
  „We did always so...for the past 40 y..
- Simple in dimension and engineering

- High material and work afford
- Renovation needs 2nd concrete layer
- Water treatment + Heating
  only possible with filled pool
- No Up-Drifting of suspensed particles
- Zones with high different chlorination,
  algae growth, sediments and „dirt“
- No reduced capacity (night) possible





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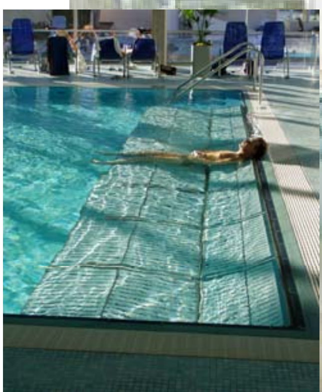
\ What happened meanwhile..

While at the famous „Felsentherme“ in Bad Gastein one existing pool had been renovacted with a 2nd concrete layer and a bottom flow system, 50 meters away a new fun and recreation pool has been built up..

...with a Horizontal Flow „Strahlenturbulenz“ System, manufactured with 2 water levels.



There are no disturbing bottom inlets, the pool has been built as a „stand-alone-solution“ within a definated concrete floor plate.

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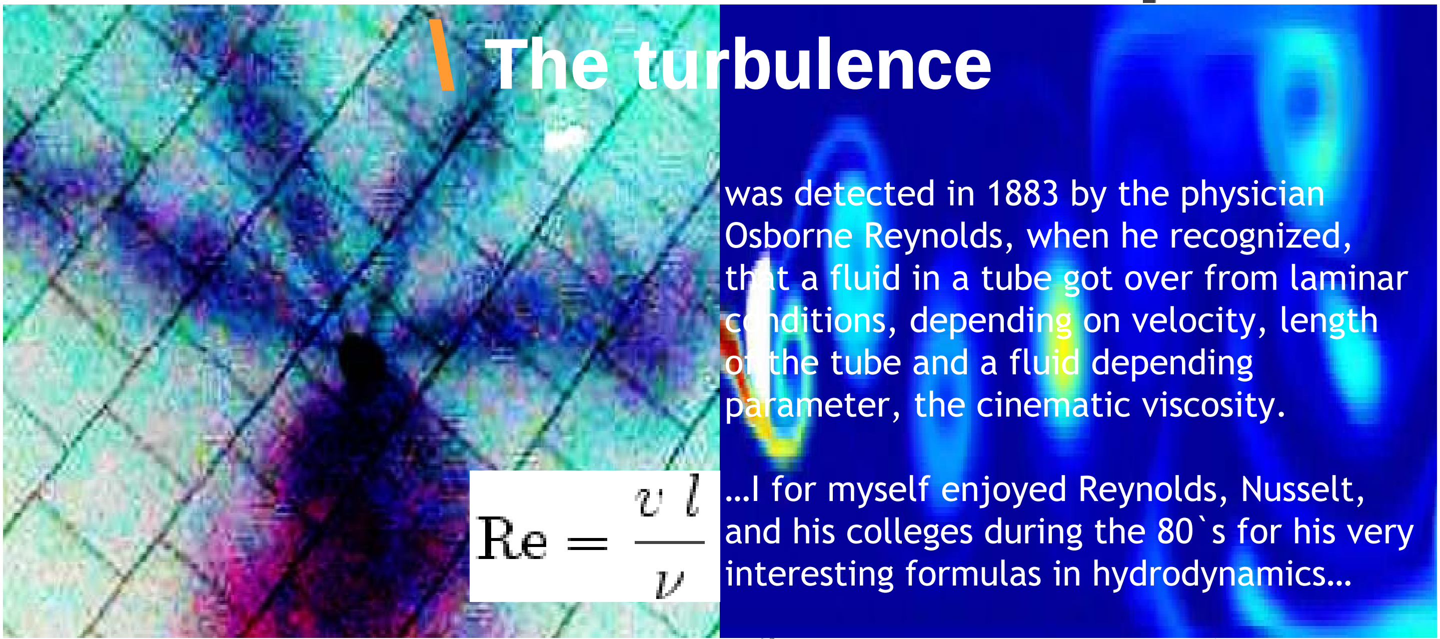

\ The turbulence

was detected in 1883 by the physician Osborne Reynolds, when he recognized, that a fluid in a tube got over from laminar conditions, depending on velocity, length of the tube and a fluid depending parameter, the cinematic viscosity.

$$\mathrm{Re} = \frac{v\,l}{\nu}$$

...I for myself enjoyed Reynolds, Nusselt, and his colleges during the 80`s for his very interesting formulas in hydrodynamics...

$$\tau_{i,j} = \rho \bar{u}'_i \bar{u}'_j = \rho \begin{pmatrix} \bar{u}'^2_1 & \bar{u}'_1\bar{u}'_2 & \bar{u}'_1\bar{u}'_3 \\ \bar{u}'_2\bar{u}'_1 & \bar{u}'^2_2 & \bar{u}'_2\bar{u}'_3 \\ \bar{u}'_3\bar{u}'_1 & \bar{u}'_3\bar{u}'_2 & \bar{u}'^2_3 \end{pmatrix}$$

$$A_i(r) = \sum_j m_j \frac{A_j}{\rho_j} W(r_i - r_j, h), \quad \nabla A_i(r) = \sum_j m_j \frac{A_j}{\rho_j} \nabla W(r_i - r_j, h).$$

$$\rho_i(r) = \sum_j m_j \frac{\rho_j}{\rho_j} W(r_i - r_j, h) = \sum_j m_j W(r_i - r_j, h),$$

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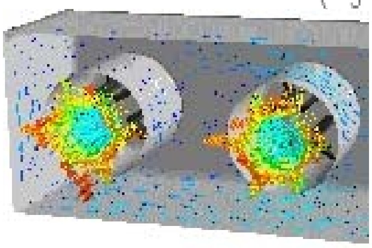
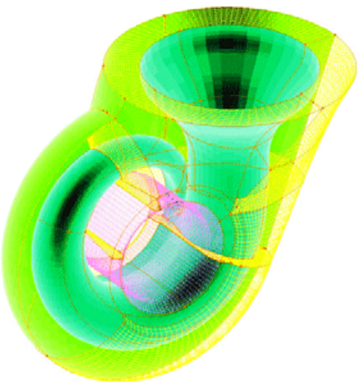
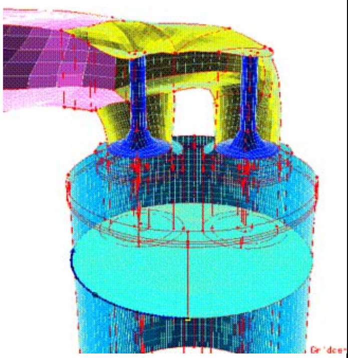
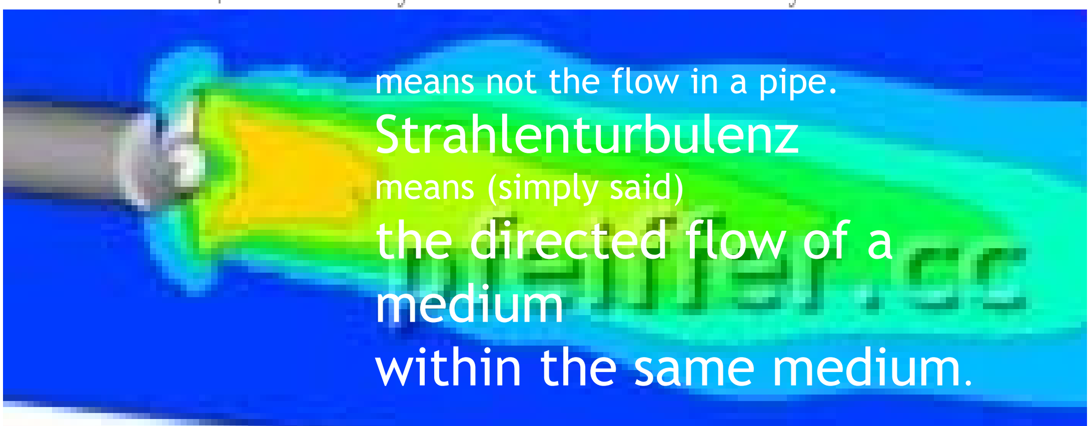
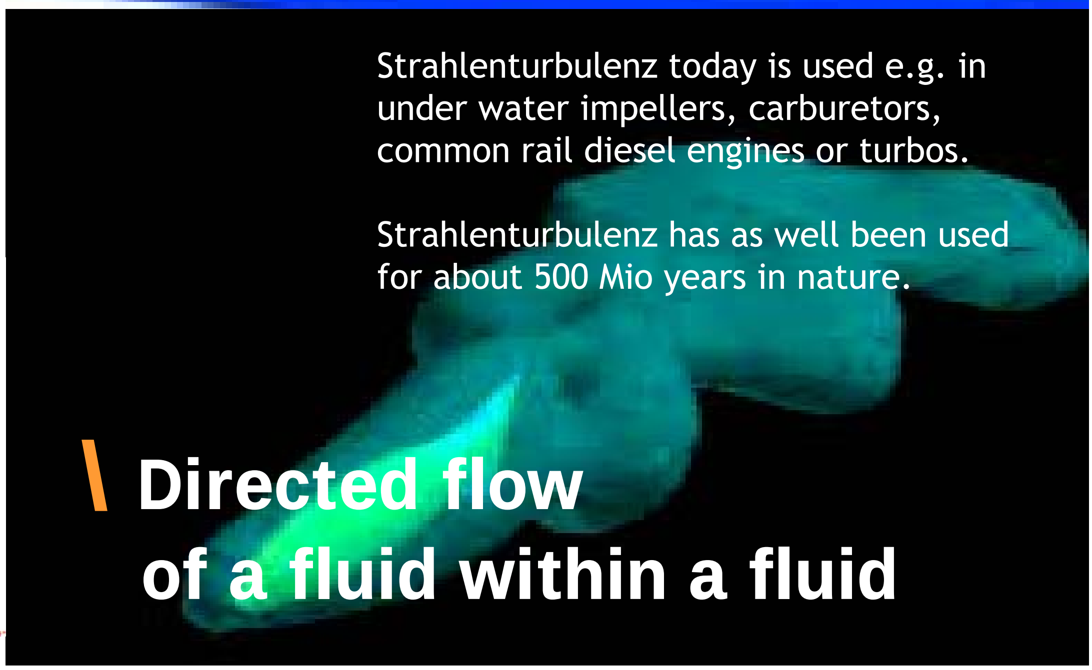








means not the flow in a pipe.
Strahlenturbulenz
means (simply said)
the directed flow of a medium
within the same medium.



Strahlenturbulenz today is used e.g. in under water impellers, carburetors, common rail diesel engines or turbos.

Strahlenturbulenz has as well been used for about 500 Mio years in nature.

\ Directed flow of a fluid within a fluid

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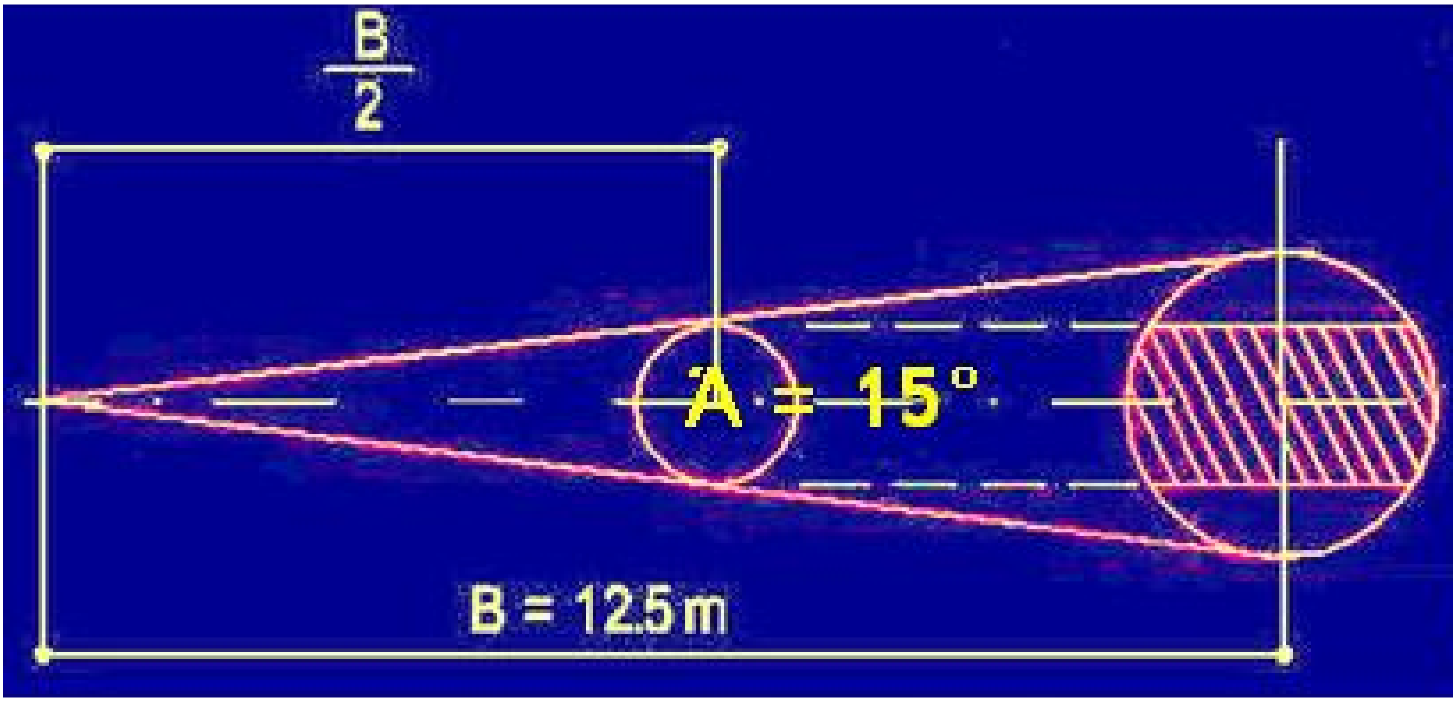
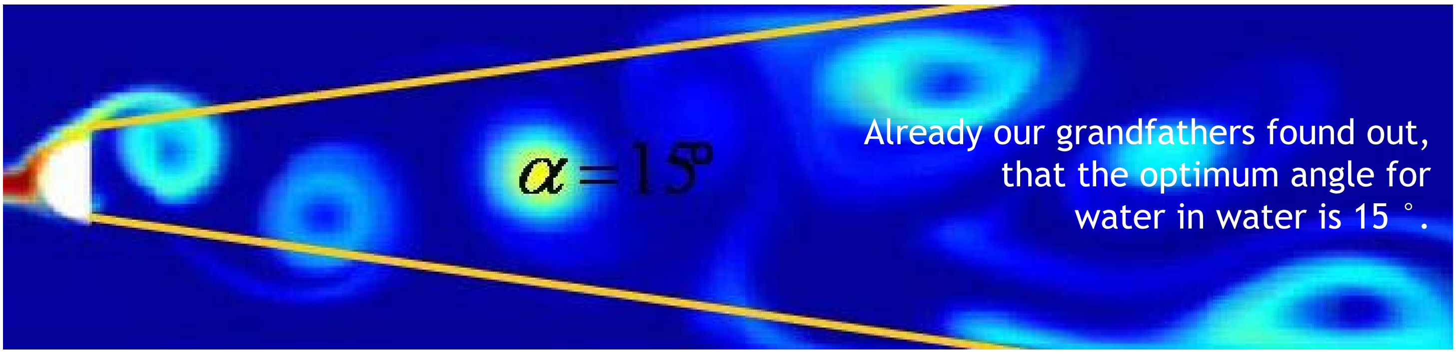
Directed flow of a fluid within a fluid





Already our grandfathers found out, that the optimum angle for water in water is 15 °.

Example
Reduced capacity (night)
Qd = 20 m^3/h
Ao at Staudruck = 4 MWS = 7,8 cm^2
Reduced C = Q/2 = 10 m^3/h
hD = h/4 =1 mWS = v^2 =35
Vm3 = 0,327 cm/s
Flow time = 6,4 min at Q = 10 m^3/h

What does this mean in **practice** ?

Let`s have a look at the World Championship Competition Pool here in Montreal,

the pool construction and the flow system.

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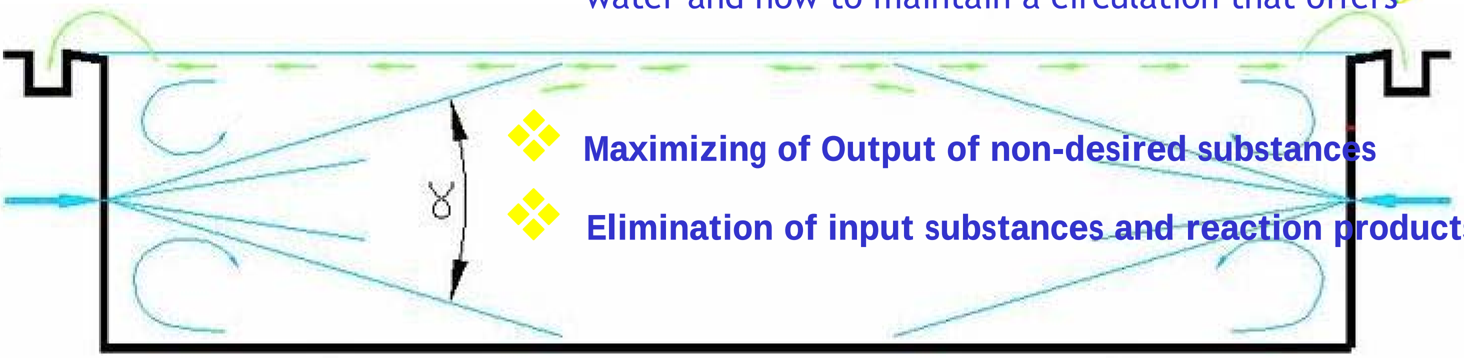
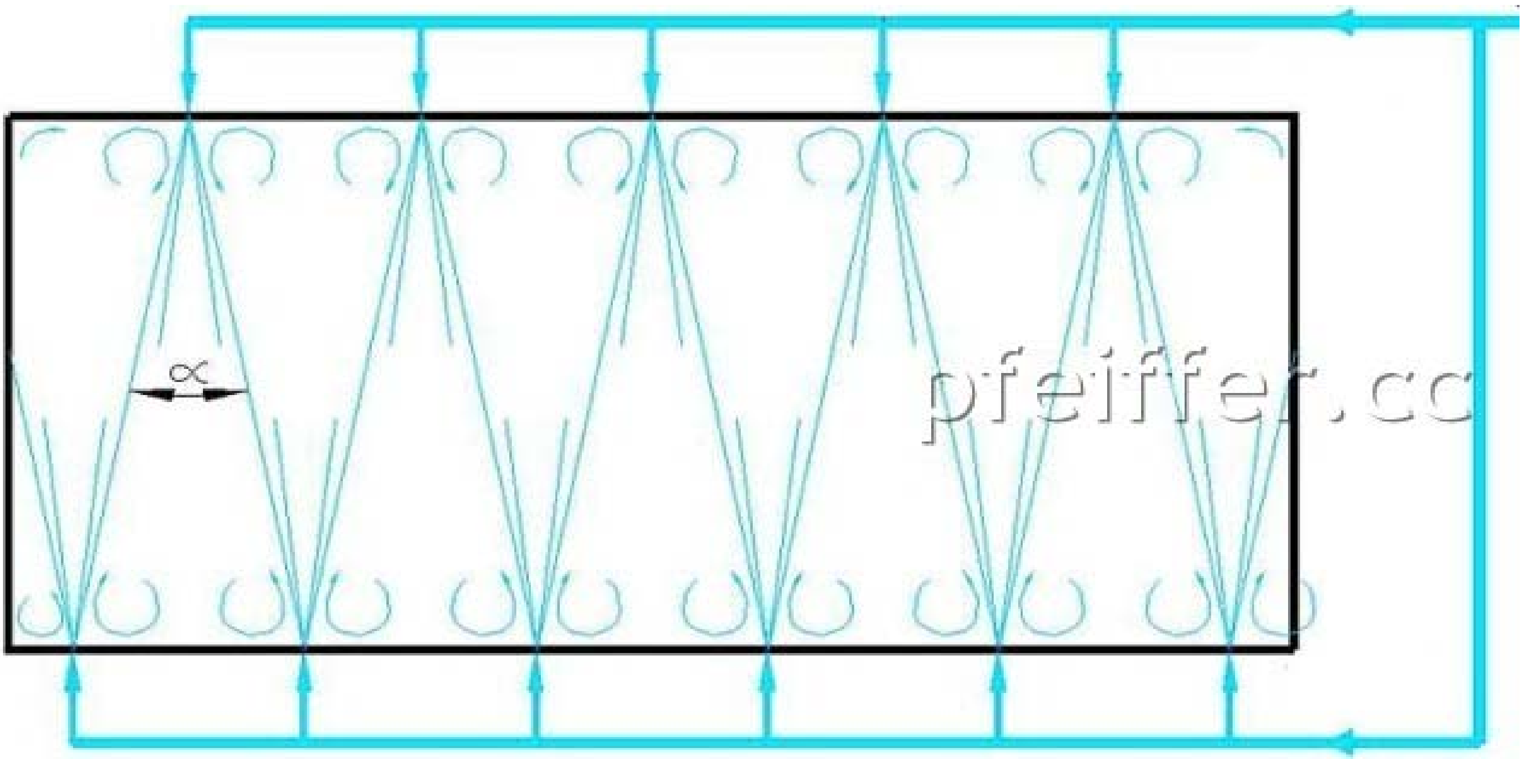
\ Calculations

Let us remember the possibilities in streaming in treated water and how to maintain a circulation that offers



- **Maximizing of Output of non-desired substances**
- **Elimination of input substances and reaction products**



Horizontal flow

Nozzle distance = e = 0,3 x B + z [m]
Nozzle position depends on geometry
Border distance = a = 0,5 to 0,75 m
Pressure = h = (mWS)
Installation height = t
t = -½ D (D<1,35 m)
t=-1,50 m (D up to 2,0 m)
t = -1,50 m and –3,30 m (D=3,80 m)

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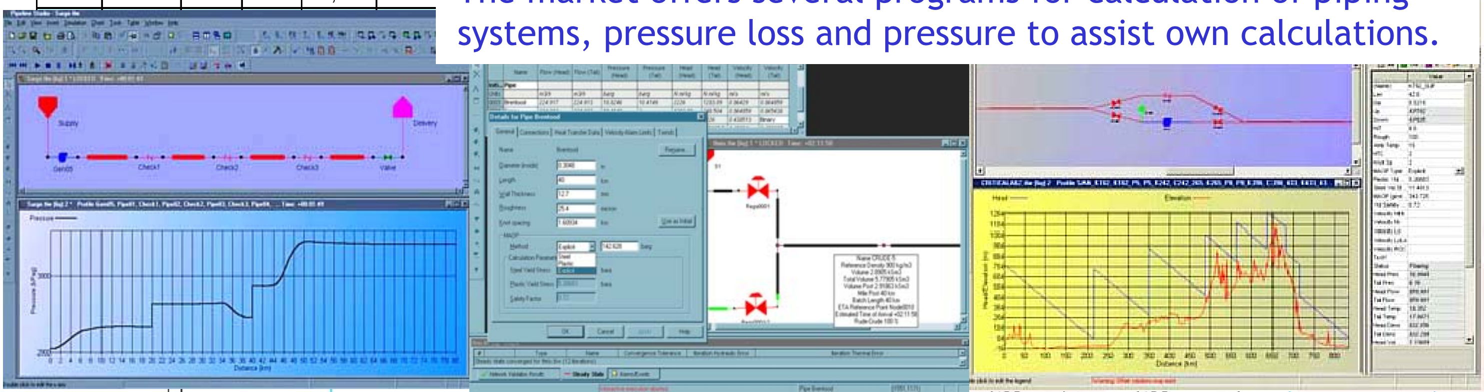
\ Calculations

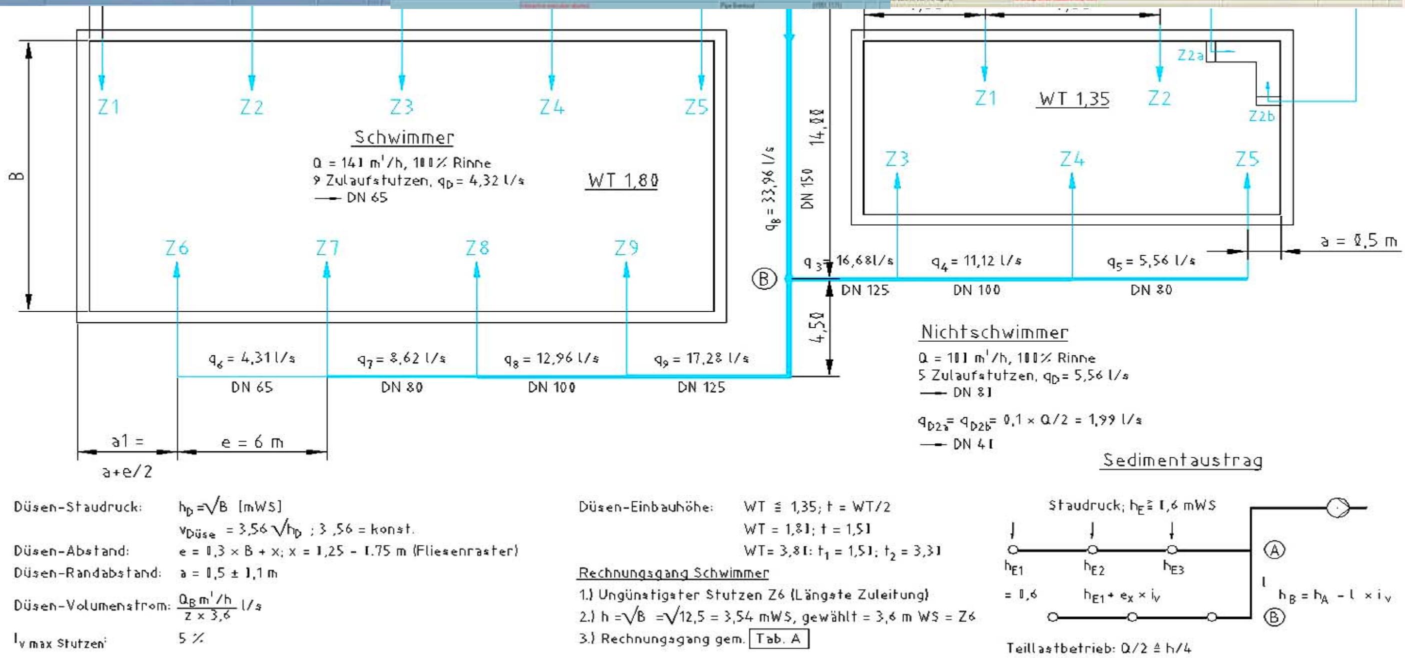
Datum:					Bearbeiter:								Tabelle A
Beckenart:					Plan-Nr.:								Blatt:......
Pumpenleistung:..............m³/h; ....l/s													
Förderhöhe:..........mWS													
Beckenbreite:.......m													
Staudruck:...........m			Düse:.........		Düsenart:............								

Depending on the capacity and the pool design the inlet and pressure of each nozzle is calculated.

1	2	3	4	5	6	7	8=6 x 7	9	10	11	12	13	14	15
Knoten	Richtung	Düse	Düse	q_D	Länge	Druckverlust	Druckverlust in der Zuleitung	h_D	Zuleitung	q_R	$v = 3{,}56 \cdot \sqrt{h_D}$	$A = \frac{q_D\,[l/s]}{v\,[dm/s]}$	$d = \sqrt{\frac{4 \cdot A\,[dm^2]}{\pi}}$	d gewählt
			DN	[l/s]	[m]	[mWS/m]	[mWS]	[mWS]	DN	[l/s]	[m/s]	[dm²]	[dm]	[mm]
		Z6	65	4,32				3,540			6,70	0,064	0,2866	29,0
	1	Z7	65	4,32	6	0,042	0,252	3,792	65	4,32	6,93	0,062	0,2817	28,0
	1	Z8	65	4,32	6	0,050	0,300	4,092	80	8,64	7,20	0,060	0,2764	28,0
	1	Z9	65	4,32	6	0,037	0,222	4,314	100	12,96	7,39	0,058	0,2727	27,0
B	1				6	0,021	0,126	**4,440**	125	**17,28**				
	-1	Z3/N	65	5,56	4	0,020	0,080	4,360	125	16,68	7,43	0,075	0,3086	31,0
	-1	Z4/N	65	5,56	6	0,028	0,168	4,192	100	11,12	7,29	0,076	0,3116	30,5
	-1	Z5/N	65	5,56	6	0,022	0,132	4,060	80	5,56	7,17	0,078	0,3141	30,5
A	1				10	0,026	0,260	**4,700**	150	**33,96**				
	-1	Z5	65	4,32	3	0,032	0,096	4,604	125	21,6	7,64	0,057	0,2683	31,0
	-1	Z4	65	4,32	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	-1	Z3	65	4,32	6									

The market offers several programs for calculation of piping systems, pressure loss and pressure to assist own calculations.





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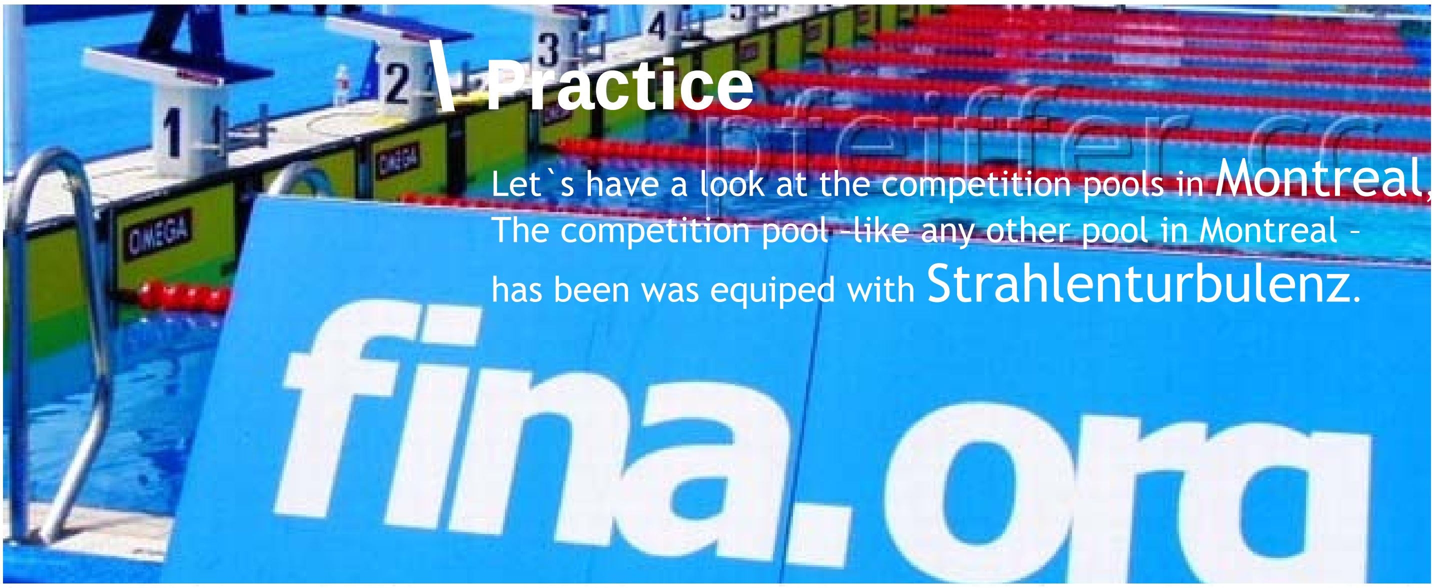
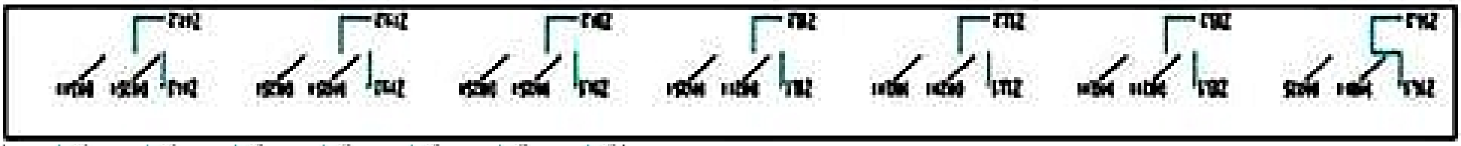
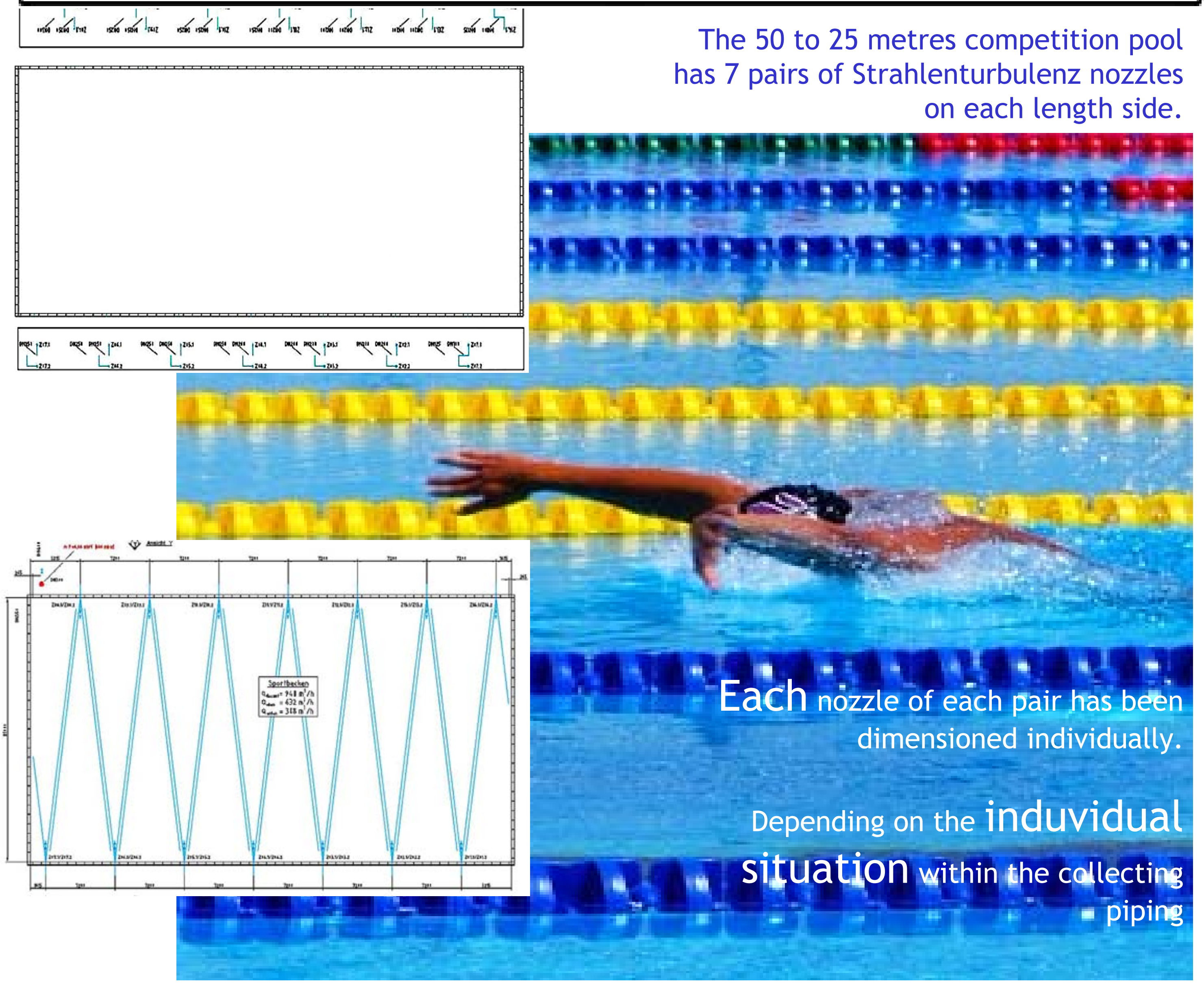


\ Practice

Let`s have a look at the competition pools in Montreal.
The competition pool -like any other pool in Montreal -
has been was equiped with Strahlenturbulenz.



The 50 to 25 metres competition pool
has 7 pairs of Strahlenturbulenz nozzles
on each length side.



Each nozzle of each pair has been
dimensioned individually.

Depending on the induvidual
situation within the collecting
piping

\ Strahlenturbulenz

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\ Practice

Let`s have a look at the competition poosl in Montreal,
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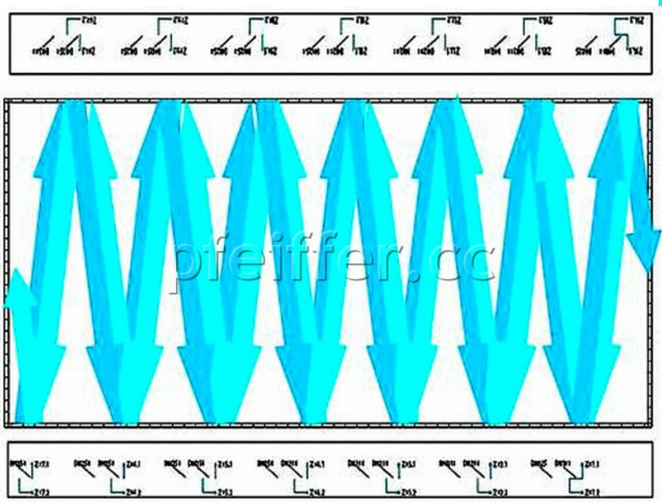

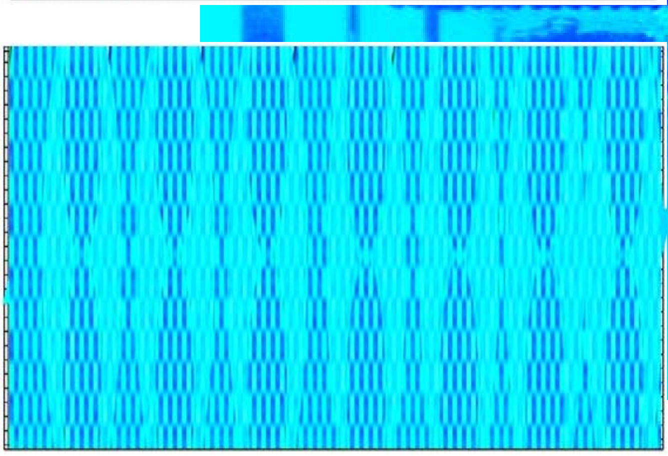

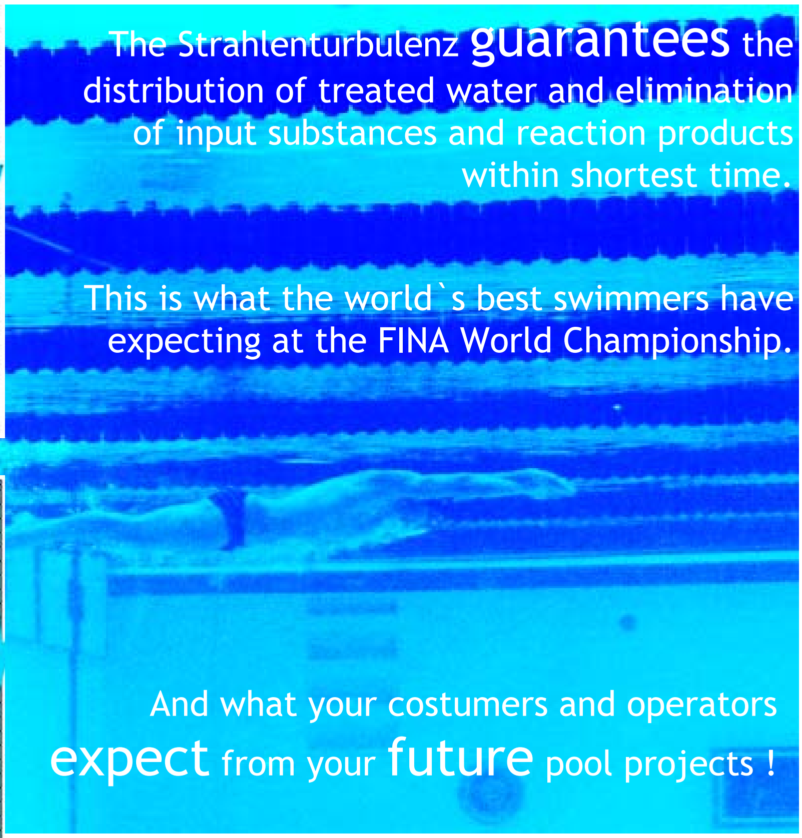

The Strahlenturbulenz guarantees the distribution of treated water and elimination of input substances and reaction products within shortest time.

This is what the world`s best swimmers have expecting at the FINA World Championship.

And what your costumers and operators expect from your future pool projects !

Strahlenturbulenz

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Summary

- Best-of Distribution of treated water
- Maximizing of output
  of non-desired substances
- Free formed pool-areas with attractions
- Low affords in material and work
- No hazard with bottom mounted parts
- Reduced capacity (night) possible + achieved !

The Author
Karl Pfeiffer

has studied chemical technology [HTL], worked for several water treatment and pool engineering and design companies.

In 1988 he founded „Pfeiffer Engineering“ and expanded continuously in planning public pool plants, hot spas and water treatment plants.

In 2000 PfeifferPartner Ltd was established and partnerships have been growing internationally for projects
within EC, the new neighbour states and overseas countries.

In 2005 Karl Pfeiffer was nominated by the courtyard as a permanent certified expert.

For additional questions **contact**

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We invite you,

to have a look at some of
our references and some interesting and creative details in our galery.