

PCC-Technology – New Concept for an Increased Operation Safety at Ozone Generators

by

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Conference on Advanced Oxidation Processes

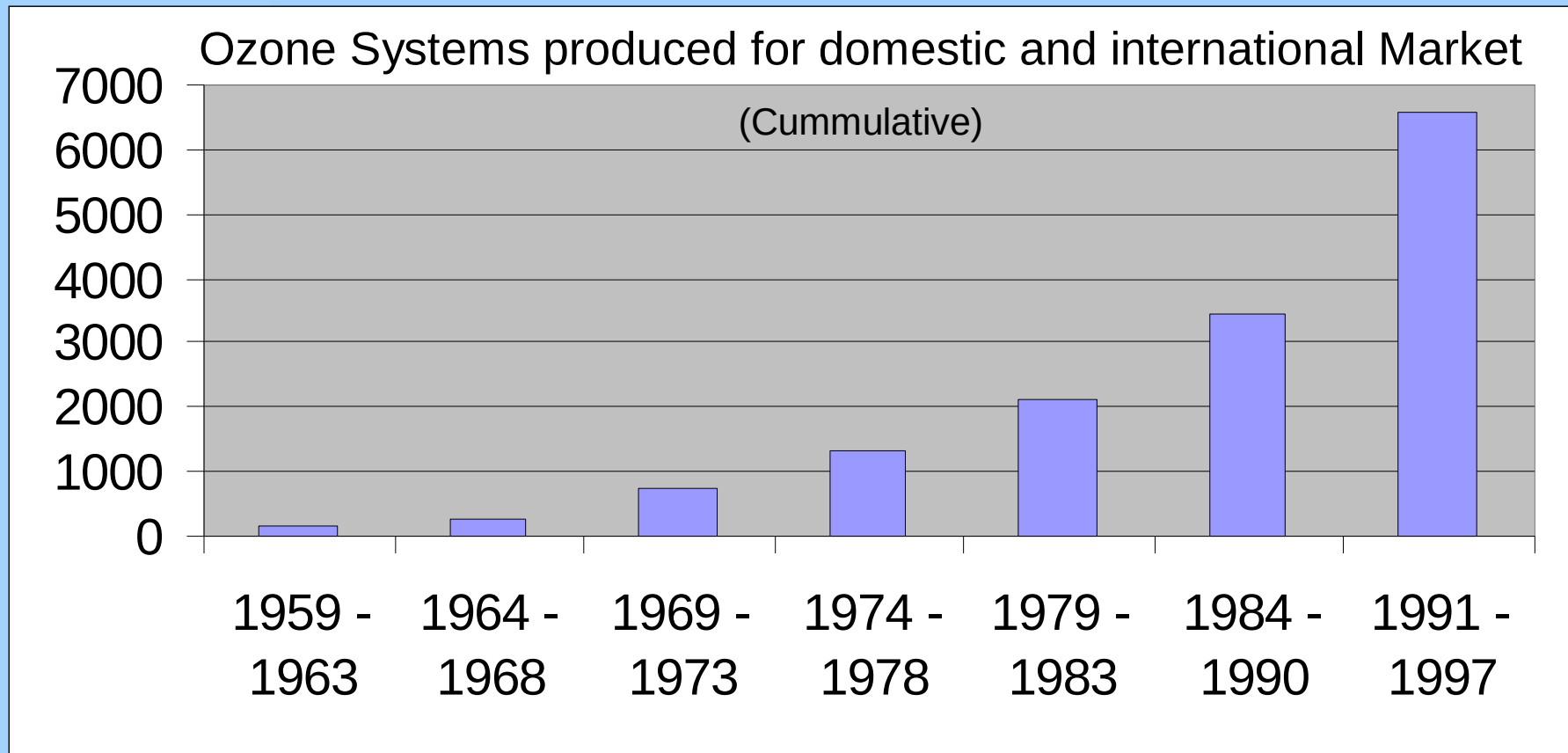
08. - 10. October 2001

Sao Pedro – SP

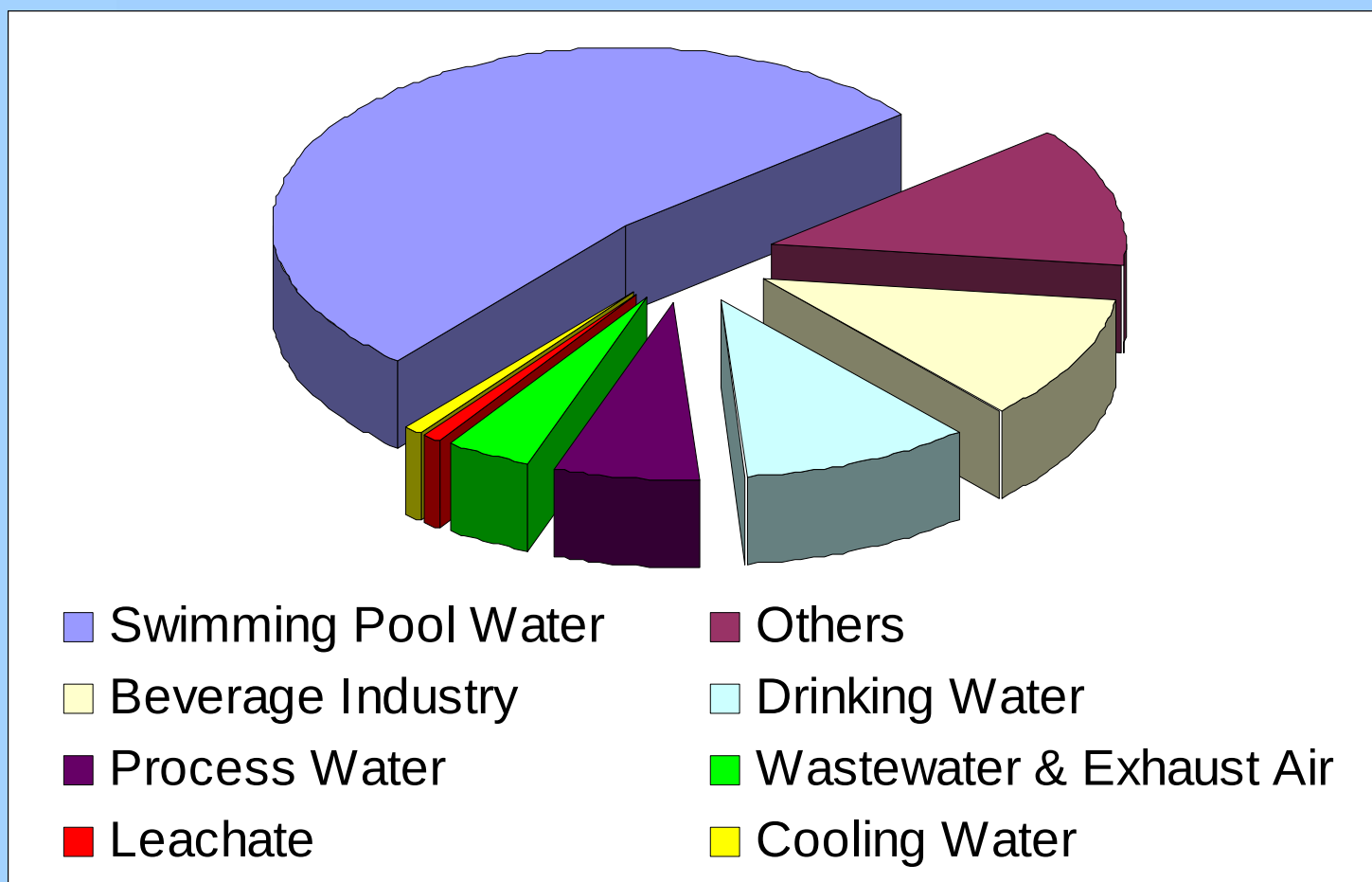
History of Ozone in Technical Applications

- ◆ 1840: Discovered by Schoenbein
- ◆ 1857: Invention of the “Ozone-tube” by Werner von Siemens, Corona-Discharge (CD)
- ◆ 1906-1925: Installations of the first ozone systems in water treatment:
 - ◆ Nice, Florence, Berlin, St Petersburg, Paris
 - ◆ Problems of the early days: High investment costs, low efficiency of the absorption equipment, unsatisfactory lifetime of ozone generators

Development of Ozone Manufacturing Companies in Germany

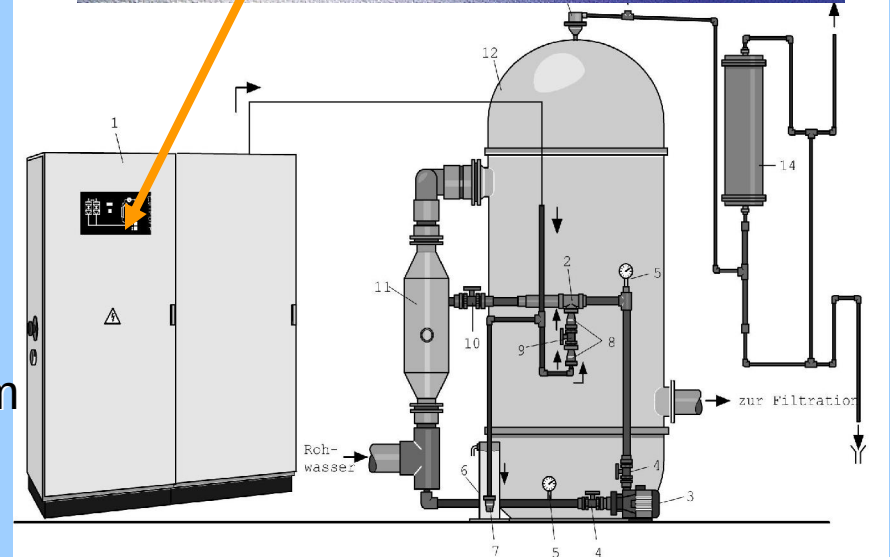
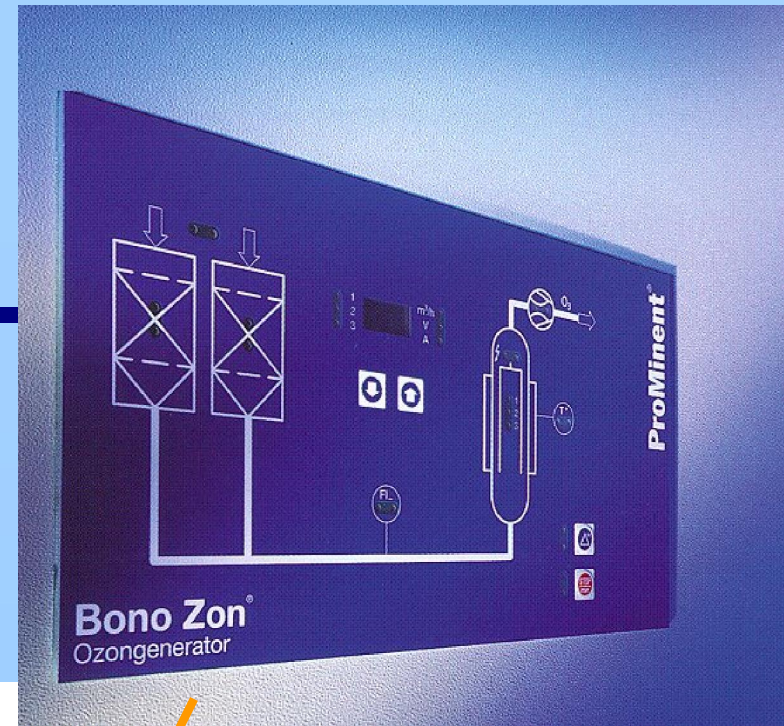


Ozone Applications

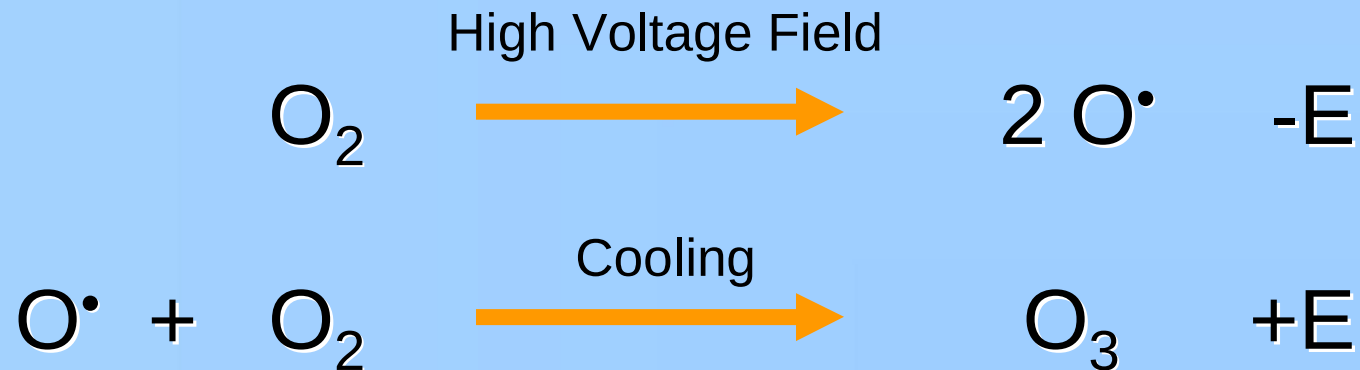


Terms in Ozone Technology

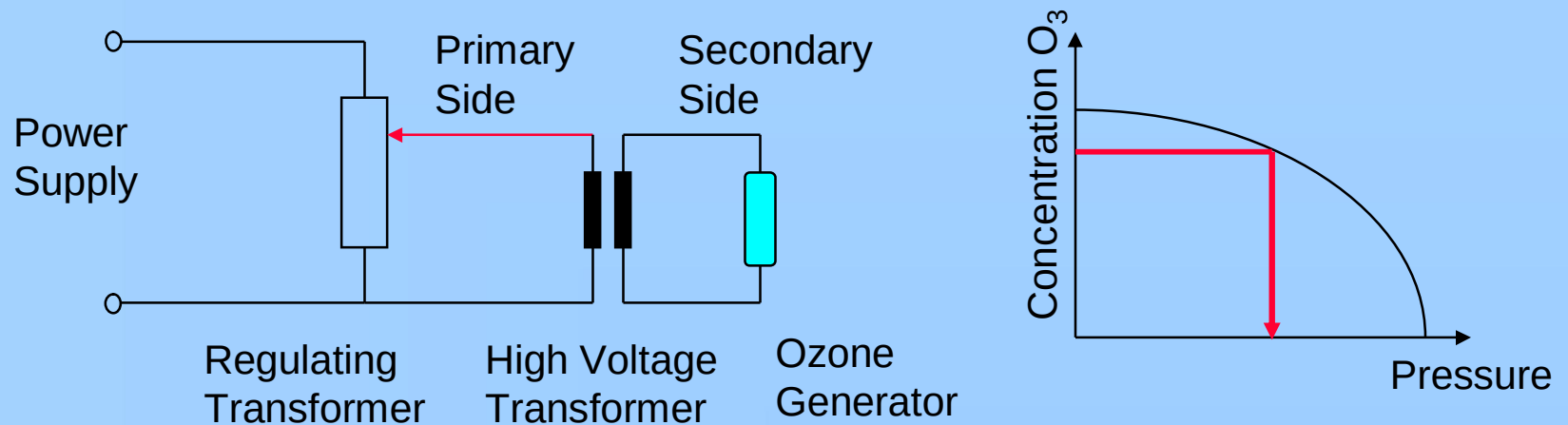
- ◆ Ozone generator
 - ◆ Producing the ozone gas
 - Air drying system
 - High voltage supply
 - Ozone generation modules
 - System control
- ◆ Ozonation system
 - ◆ Ozone in contact with the water
 - Ozone generator
 - Ozone transfer system
 - Reaction tank
 - Residual ozone elimination system



Ozone Production: Basic Reactions in the Generation Module



Standard Control of Ozone Generators



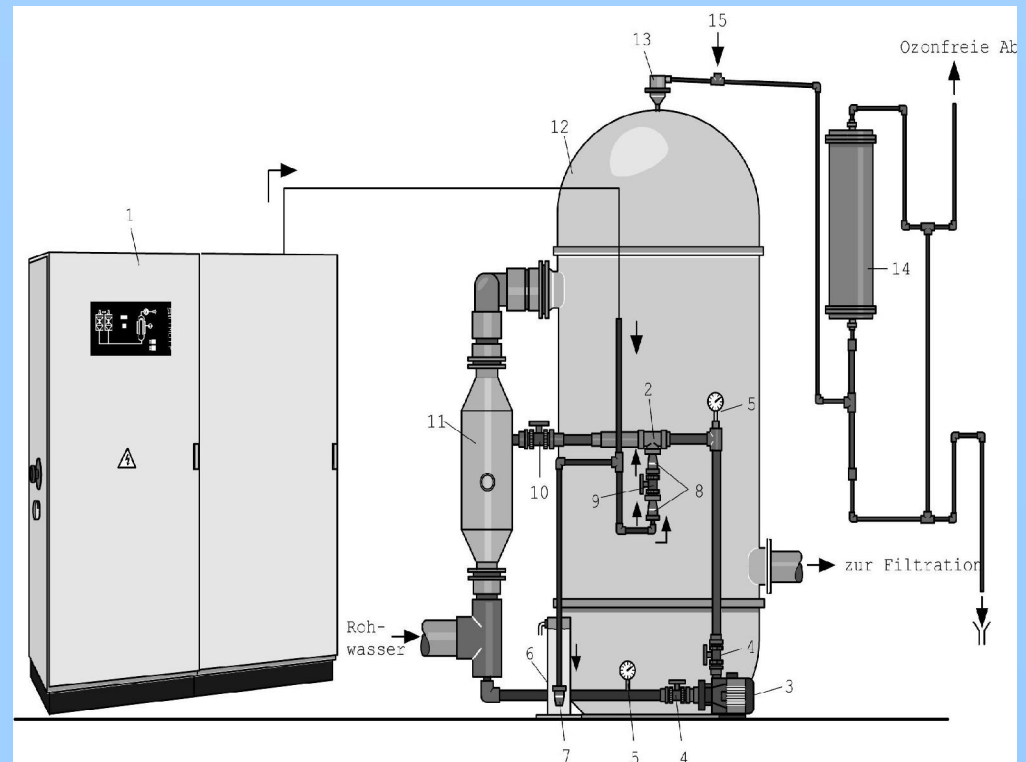
- ◆ The Resistance of the Ozone Generator can be expressed as „Z“ = Impedance
- ◆ $Z = f(\text{pressure inside the Generator})$
- ◆ If the pressure in the ozone generator rises:
- ◆ The resistance of the ozone generator rises, too

Consequences for the Design of a Standard Ozone Generator

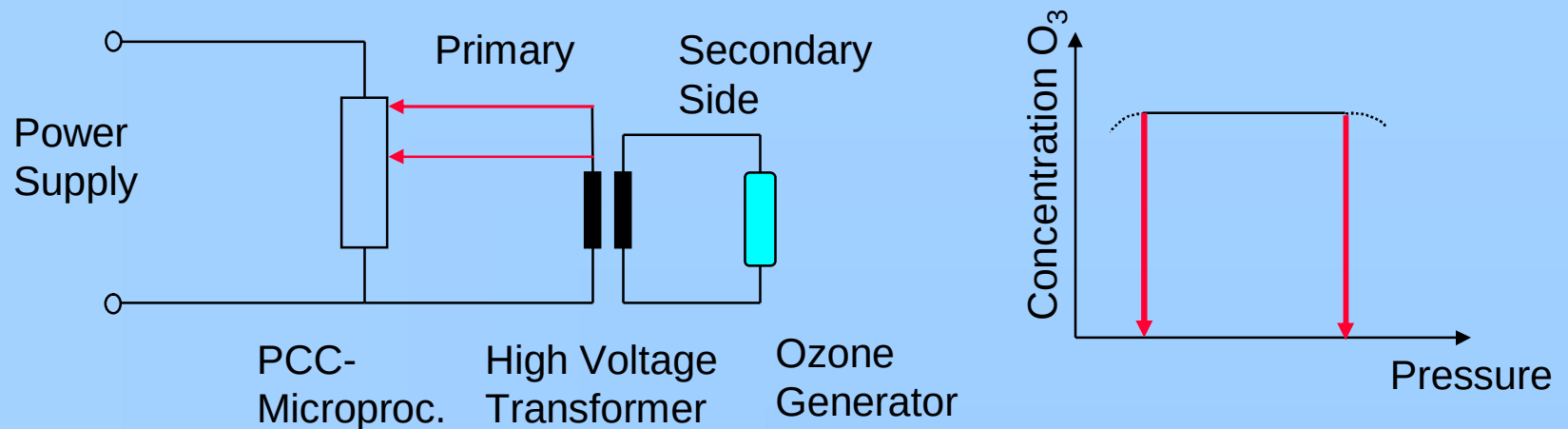
- ◆ The pressure in the ozone generator needs to be kept constant
- ◆ The ozone transfer system needs careful engineering
 - ◆ Injector, booster pump, mixing systems ...
- ◆ In case of a shortcut inside the generator the primary current rises drastically

Standard Ozonation System

- Booster pump
- Injector
- Pressure gauges
- Mixing vessel
- Venting valve
- Reaction tank
- Residual ozone gas elimination system



New: PCC – Primary Current Controlled Ozone System



- ◆ A microprocessor controls the primary current
- ◆ I_{prim} remains always constant:
 - ◆ If the pressure rises, the high voltage rises
 - ◆ If the pressure is reduced, the high voltage is reduced
- ◆ The ozone concentration and ozone output remains constant

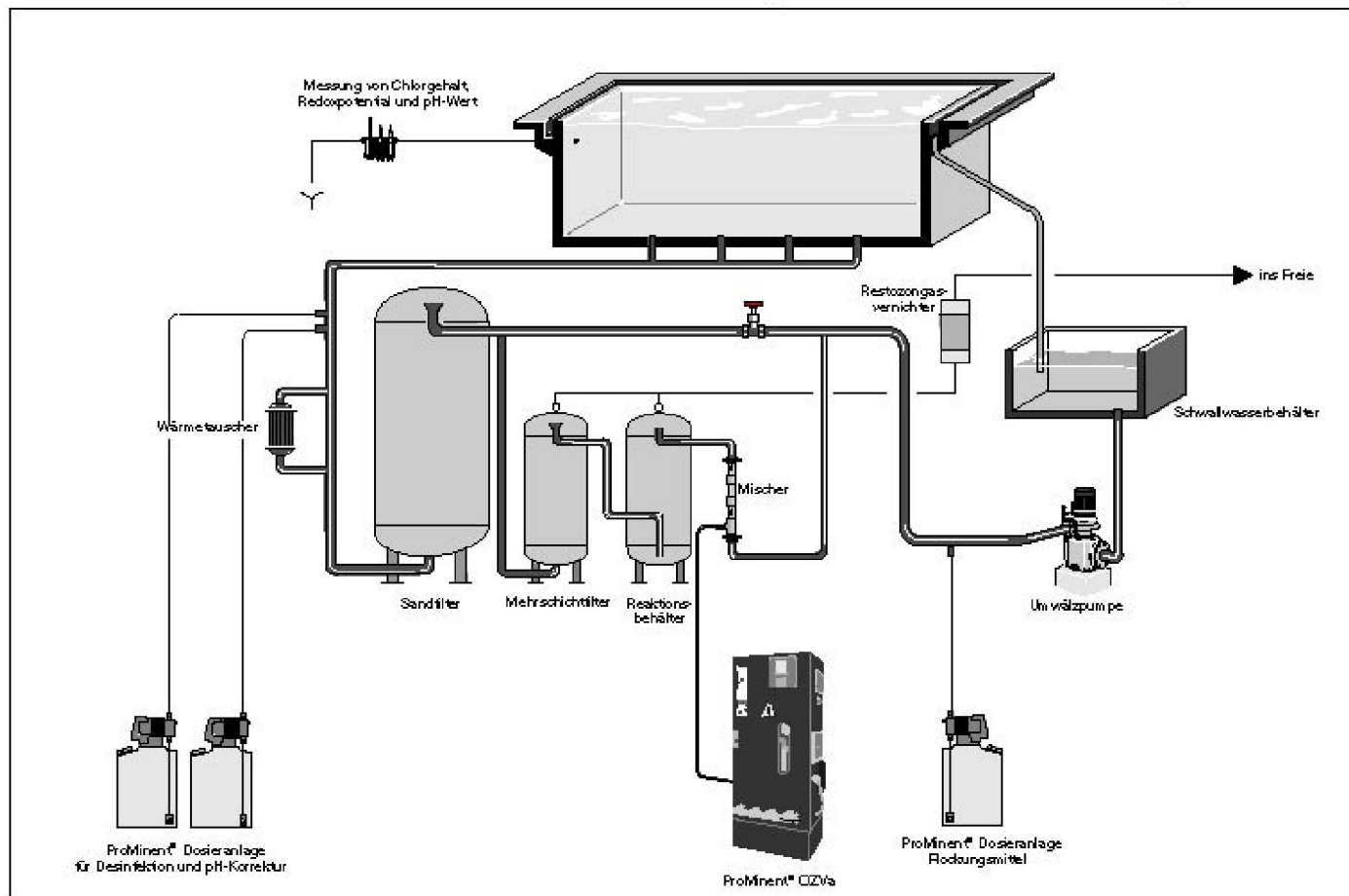
Operation of a PCC Ozone Generator

- ◆ Ozone generation based on a controlled current source
- ◆ The ozone production is not influenced by the pressure at the dosage point
- ◆ Simple ozone transfer system
 - ◆ Static mixer
- ◆ Complete protection of the electrical components if a shortcut occurs in the generator



Example of an Installation: Bypass-Ozonisation at a Swimming Pool

Schwimmbadwasser - Aufbereitung mit Teilstromozonisierung



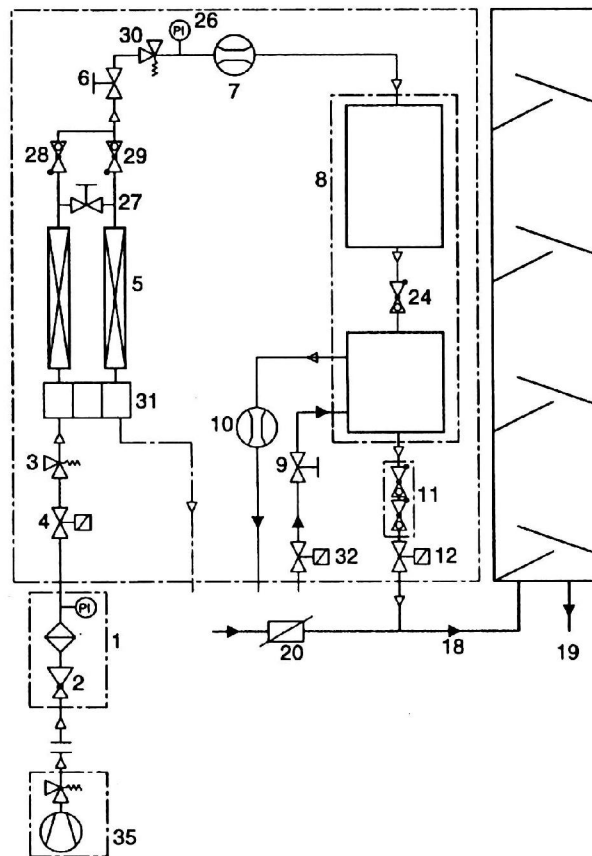
Compact Ozonization System



- ✦ Reaction tank
- ✦ Aeration valve
- ✦ Residual ozone elimination
- ✦ Gas warning device



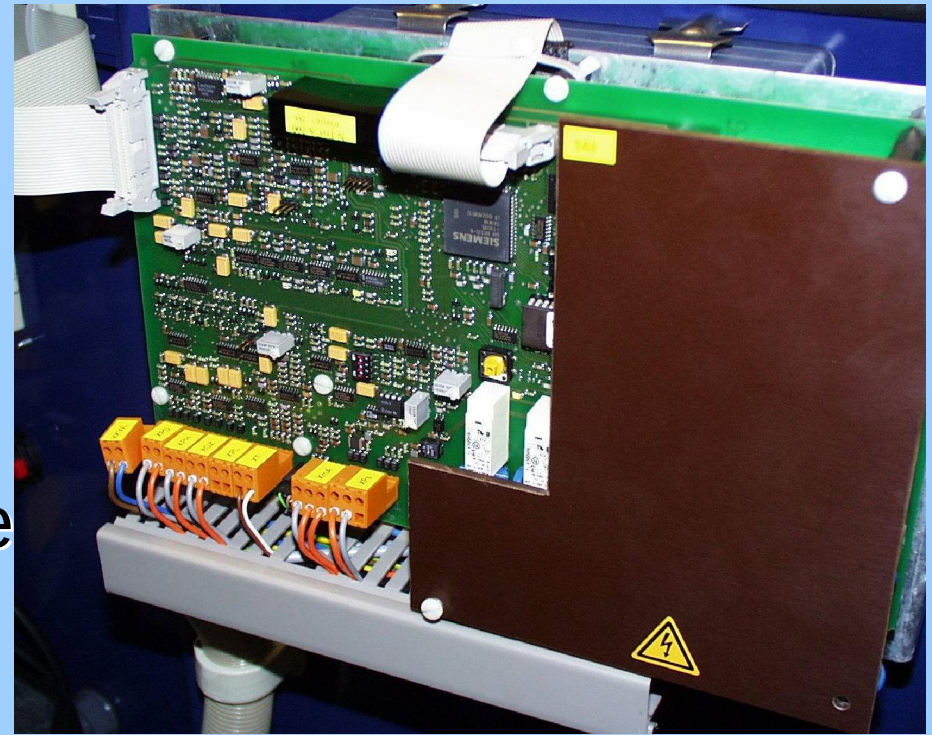
Pneumatic & Hydraulic Flow Diagramm



- 1 Air cleaning unit
- 2 Pressure release valve
- 3 System inlet, bypass valve, 7 bar
- 4 System inlet, solenoid valve
- 5 Adsorber drier
- 6 Regulating valve, process air
- 7 Flow meter, gas
- 8 Ozone generator
- 9 Corner valve, cooling water inlet
- 10 Flow meter with min. level float switch for cooling water
- 11 Spring-loaded double non-return valve
- 12 Solenoid valve, ozone outlet (ozonated air loading valve)
- 18 Mixer
- 19 Mixing tank
- 20 Flow monitor for raw water
- 24 Non-return valve
- 26 Pressure gauge, ozone generator operating pressure
- 27 Regulating valve, regenerating air
- 28 Non-return valve, adsorber drier
- 29 Non-return valve, adsorber drier
- 30 Bypass valve, 2.5 bar, ozone generator
- 31 Solenoid valve block, adsorber drier
- 32 Solenoid valve, cooling water inlet
- 35 Compressor unit with pressure vessel, bypass valve and push switch (6 bar < p < 8 bar)

Signal Overview

- ◆ Input Signals
 - ◆ 0/4 – 20 mA Signal
 - ◆ Pause Input
 - ◆ Raw water flow
 - ◆ Gas warning device
- ◆ Output Signal
 - ◆ Alarm relays

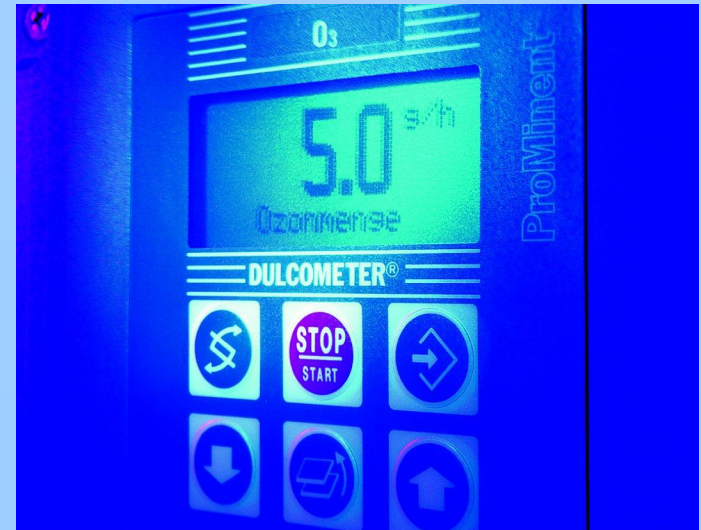


Internal Monitoring

- ◆ Gas flow measurement, digital
- ◆ Temperature measurement of the ozone generation module
- ◆ Cooling water flow, min.-monitoring
- ◆ Condensate bleed-off at the air receiver of the compressor
- ◆ Supply voltage
- ◆ Primary Current

Further Benefits of the PCC-Technology

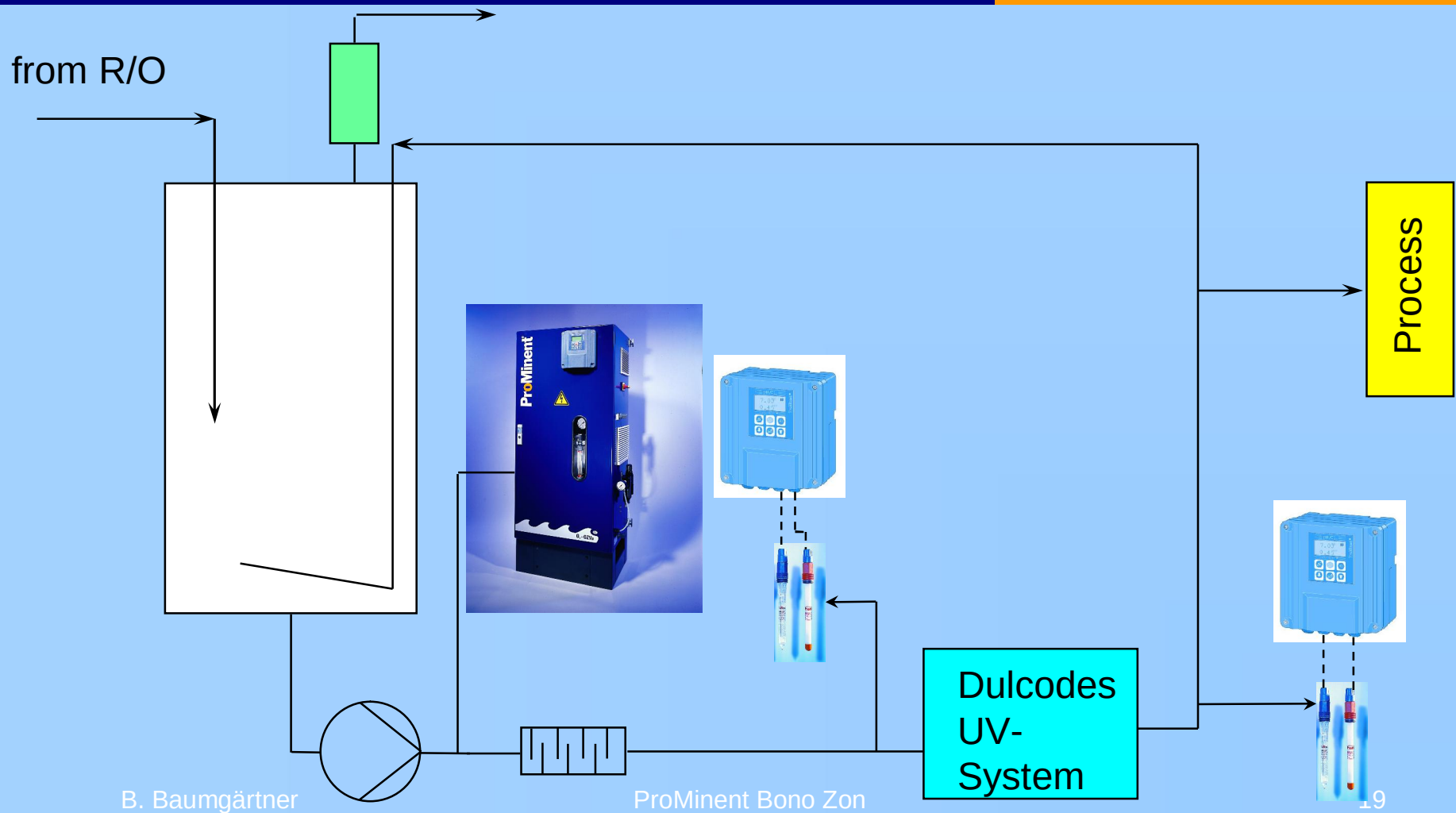
- ◆ Display showing ozone production in „g/h“
 - ◆ Due to the fact that the primary current is directly proportional to the ozone output
 - ◆ Gas flow and temperature are used to correct the value



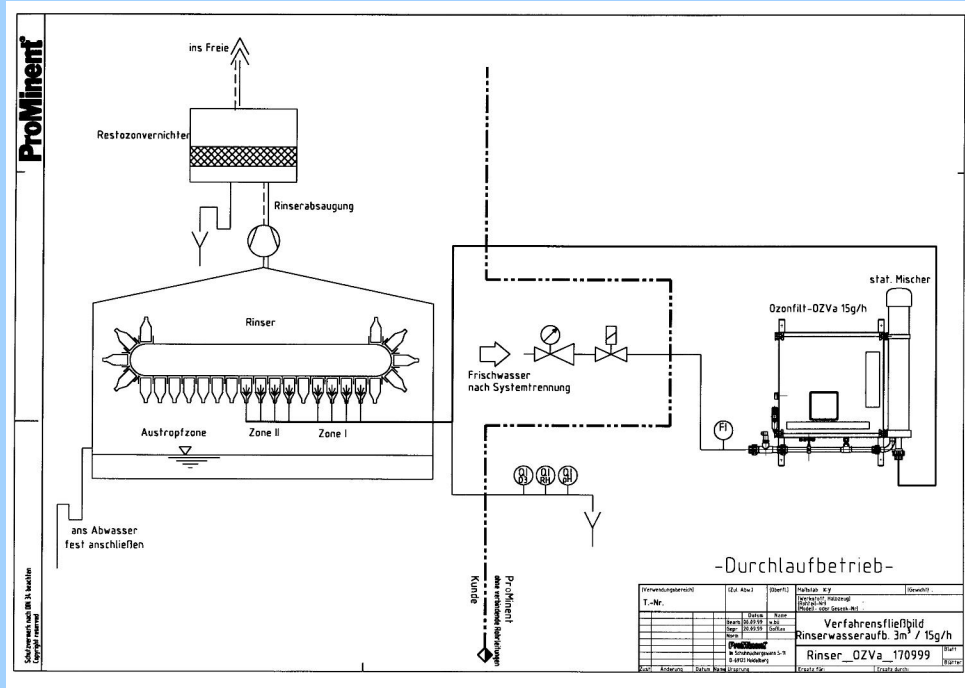
Silent Electrical Discharge Ignition Limit

- ◆ Variation of the Ozone performance over the full range: 3 – 100%
 - ◆ Ignition voltage level is compensated by microcontroller
- ◆ Variations of the supply voltage are balanced automatically

Process Water Ozonisation with Low Conductivity



Use of Ozone at the Rinser



Filling of Wine in South Africa

Summary

- ◆ The introduction of the PCC-technology (**p**rimary **c**urrent **c**ontrolled) offers complete protection of the electric components of an ozone generator.
- ◆ Furthermore it allows a digital display of the ozone capacity in “grams/hour”.
- ◆ Any desired quantity of ozone between 3% and 100% of the nominal capacity can be reproducibly adjusted.