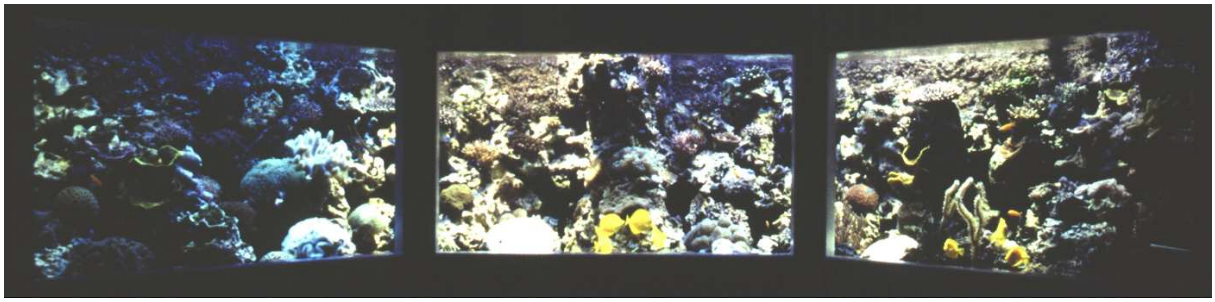
From the AquaCare laboratory

Characterization of the AquaCare *Turbo* Chalk Reactor size 7

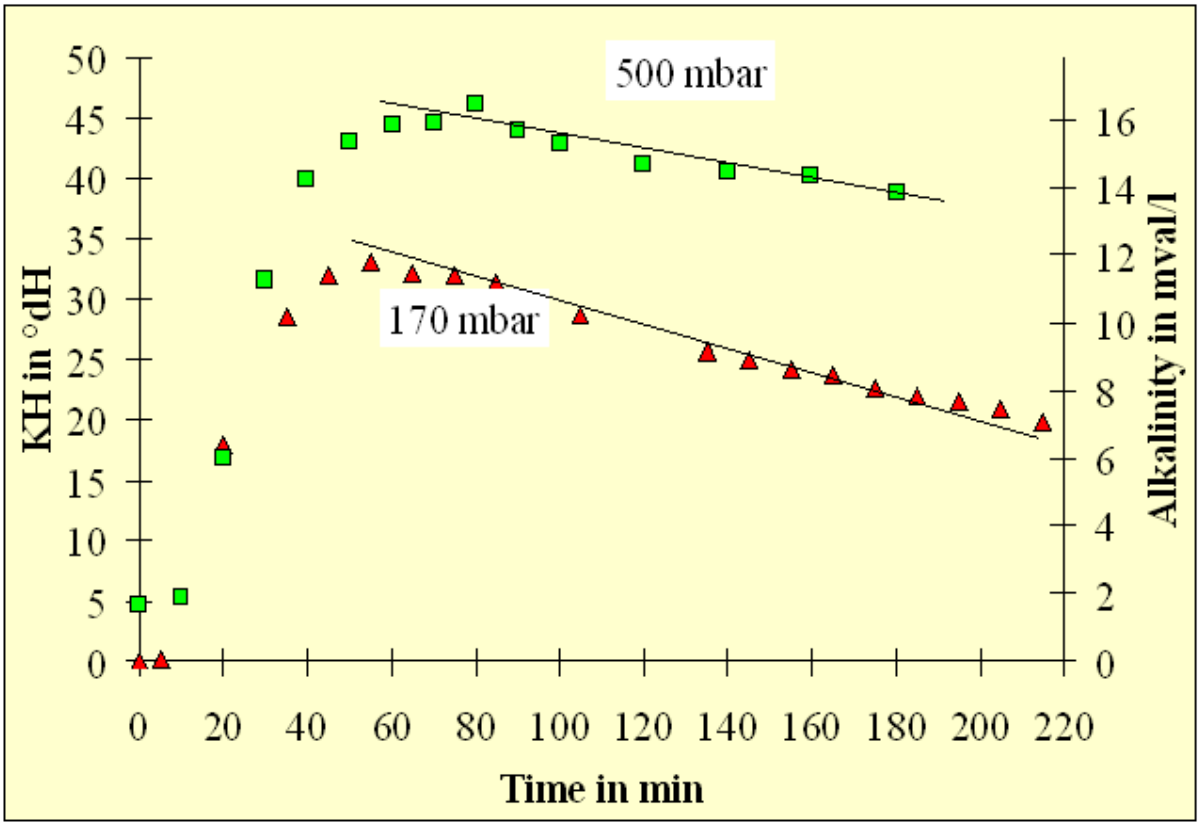
The experimental aquarium

The aquarium system consists of two tanks, which are connected by a common circuit. The living room aquarium is a pentagon with a windscreen of 2.80 m × 1.20 m and holds approx. 5.7 m. The cellar aquarium is a nine-corner with two front-panes of 1.20 m × 0.73 m and one with the dimensions 1.30 m × 0.73 m and holds approx. 5.4 m^3. The total system thus contains approx. 11 m^3 plus approx. 2 m^3 in the filter system. The system is operated with two skimmers with 1.5 m^3/h air intake and two circulation pumps with 12 m^3/h each. For the flow a pump with 26 m^3/h and 8 turbells with 8 m^3/h each are operated in each aquarium - so together a theoretical total capacity of 180 m^3/h. The nine-corner aquarium of the cellar is illuminated with 4 × 1000 W HQI, 2 × 400 W HQI and 27 × 58 W blue fluorescent tubes. Above the living room aquarium hung 3 × 400 W HQI, 4 × 250 W and 15 × 58 W blue tubes. After approx. 1½ years the power was increased to 3 × 1000 W, 2 × 400 W, 2 × 250 W and 15 × 58 W blue tubes - when all luminaires are powered, they consume a total of 11.5 kW plus the power of the ballasts. The aquarium system is inhabited by about 200 fish and 450 corals - mainly hard corals - and a lot of sea urchins, snails and other invertebrates.



Due to the enormous water movement and the extremely strong illumination a very high dissolving lime requirement of the lower animals had to be expected. Already after half a year the first hard corals were used, after the green algae growth was fought with sea urchins, turbo snails, 10 large *Zebrasoma flavenscens* and some other algae-eating animals.

Performance diagram at 170 and 500 mbar



Produced carbonate hardness or alkalinity depending on the running time of the reactor at 170 mbar (normal pressure) and 500 mbar internal pressure.

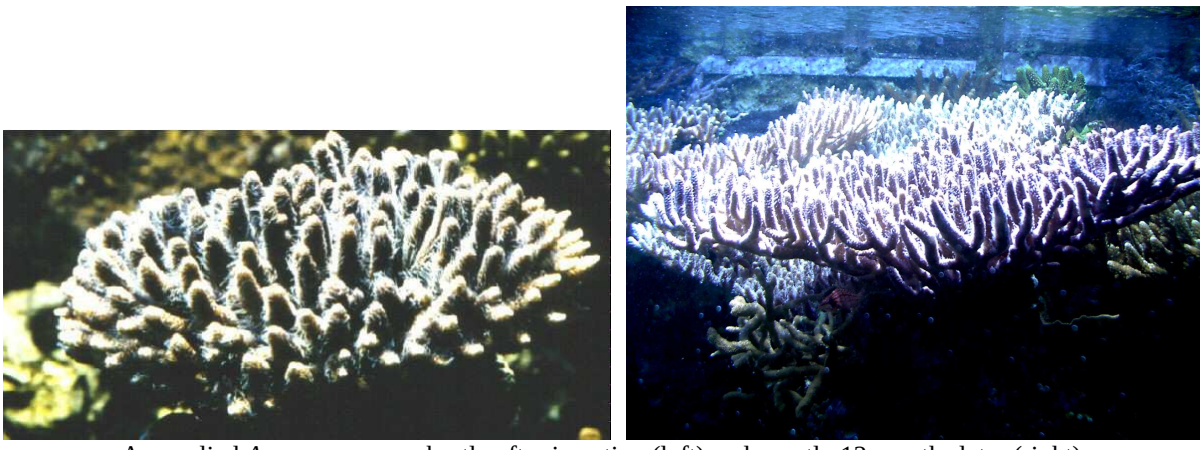
First, the produced hardness was carried out at a water inlet flow of 100 l/d and normal pressure. The normal pressure is 0.17 bar due to the water column in the reactor. The first measured maximum values did not surprise us: 44°dH with an inlet water of 10.9°KH. This corresponds to a maximum output of approx. 70,000 hardening litres per day (average values of 80 to 100% effectiveness).

The second test was carried out at 0.5 bar overpressure. All systems withstood the pressure and functioned without problems. The CO_2 supply was set at 5 litres per hour. As soon as the pressure maintaining valve was set to the set point, the internal pressure increased to 0.5 bar and at the same time the gas previously visible in the CO_2 pipe quickly decreased. At the higher working pressure, the gas could diffuse into the water much more effectively. Only after a few minutes the further CO_2 supply was able to generate the desired gas bubble in the CO_2 pipe again, so that the *Turbo* Chalk Reactor control system could start up. The measured degree of hardness was significantly higher at 58°dH - at 100 l/h flow rate. The maximum daily output minus the 12°dH already present in the aquarium water is thus almost 100,000 litres of hardness (averaged values of 80 to 100% effectiveness).

The experiments became interesting when the long-term production was observed. As expected - as with all calcium reactors - the curve at normal pressure decreases slowly after the start phase and optimum operation due to the accumulation of foreign gases. Venting every 95 minutes is useful to optimise operation at 80 - 100% efficiency.

The 0.5 bar curve shows that the time after which the efficiency slowly decreases is much longer. Ventilation only makes sense after 150 minutes at the earliest. This can be explained by the lower degassing of the foreign gases at higher pressures. If the full capacity of the reactor is not required, the time for the next venting can of course be further delayed. CO_2 is saved through better use.

At present, the *Turbo* Chalk Reactor 7 runs at this "hobby aquarium" at 0.5 bar overpressure and a running time of 8-9 hours per day - this corresponds to a theoretical production of approx. 35,000 hardening litres. Even if the animals should grow even more - and they certainly will - we do not see any problems that the turbo-reactor can produce enough dissolved lime. The running time can be increased and the water throughput through the reactor can be increased to 500 litres per hour. Based on a theoretical production of 30 kg $CaCO_3/m^2$ * a in natural reefs and including the dimensions of the aquarium in the calculation, we can assume a daily requirement of 56,000 hardened liters. Of course, the losses due to precipitation or the artificial conditions under which the corals grow, or inflows and outflows due to water changes (100 litres per day after all) are not taken into account.



An applied *Acropora* spec. shortly after insertion (left) and exactly 12 months later (right)

Our estimates have shown that the maximum capacity of the installed system is around 500,000 hardness liters per day, which means that much larger and more extreme hard coral aquariums can be operated with reactor size 7.

The largest reef aquarium ever operated with a size 8 AquaCare *Turbo* Chalk Reactor is the 900 m3 aquarium at Afrykarium, Wroclaw Zoo, PL.