

CO₂ Removal and Stripping Column Ventilation Rate at Bell Aquaculture

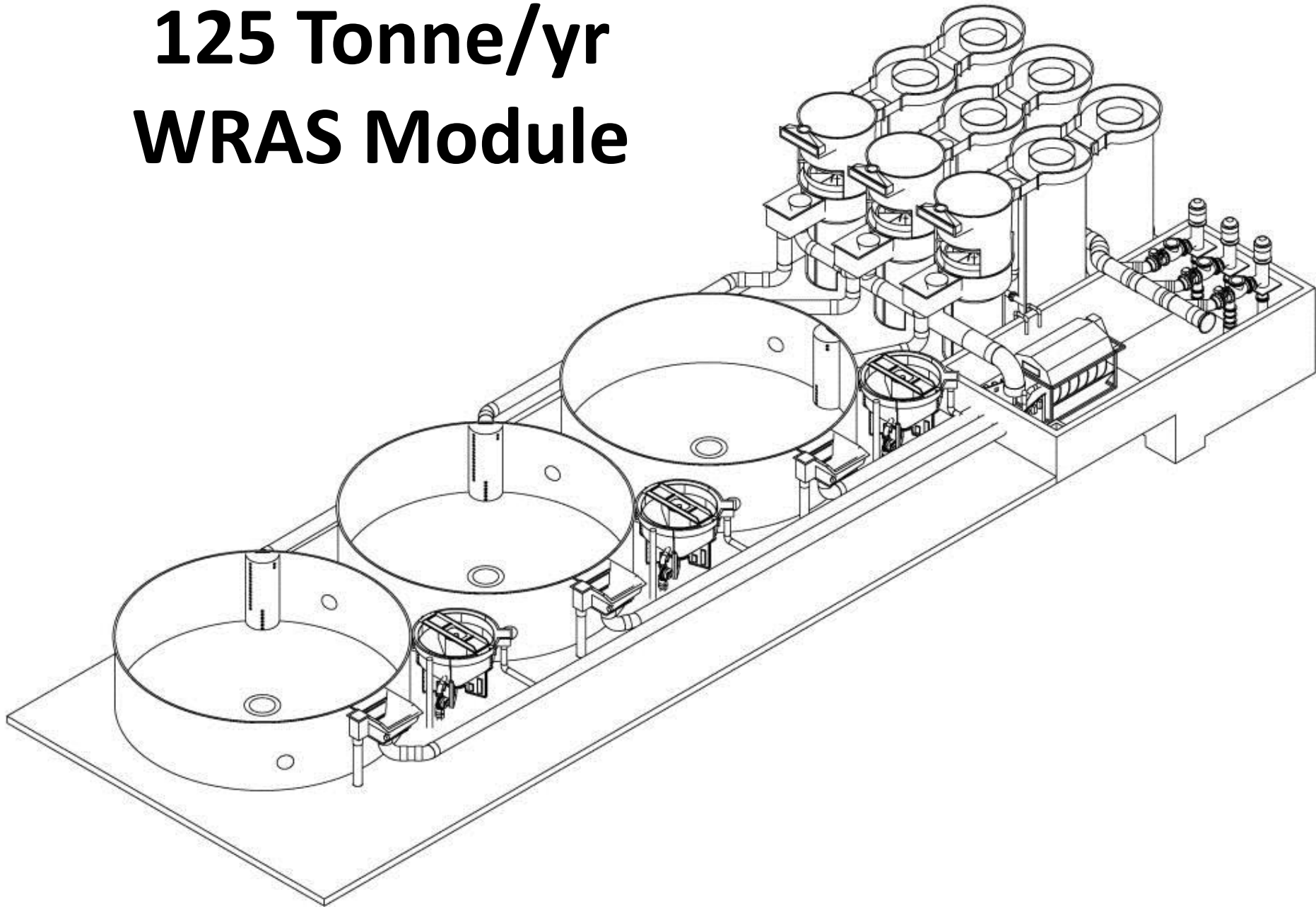
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FRANATECH



THE
CONSERVATION FUND

125 Tonne/yr WRAS Module



Design of Bell Aquaculture Growout WRAS for Yellow Perch

- 26 m³/min (6,900 gpm) total water recirculating flow rate in each WRAS
 - 85 HP energy for water recirculation
 - Pumping, aeration, drum filtration, oxygenation
 - 30 minute culture tank retention time
 - 2,300 gpm/tank
 - 20 to 40 gpm makeup flow per WRAS

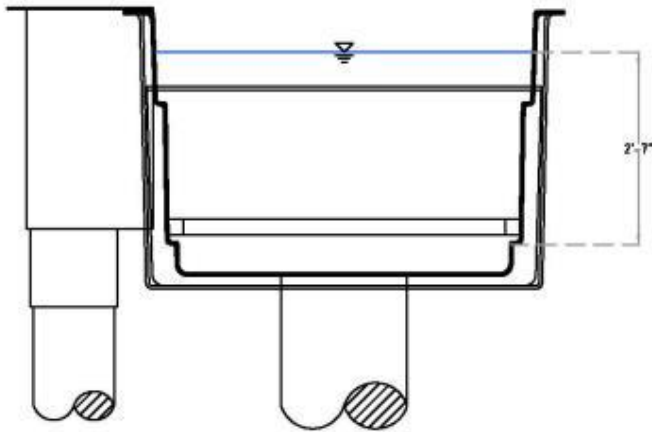
Trout & Salmon Production Tanks (10.7 m ϕ x 3.05 tall; 260 m³ culture volume)



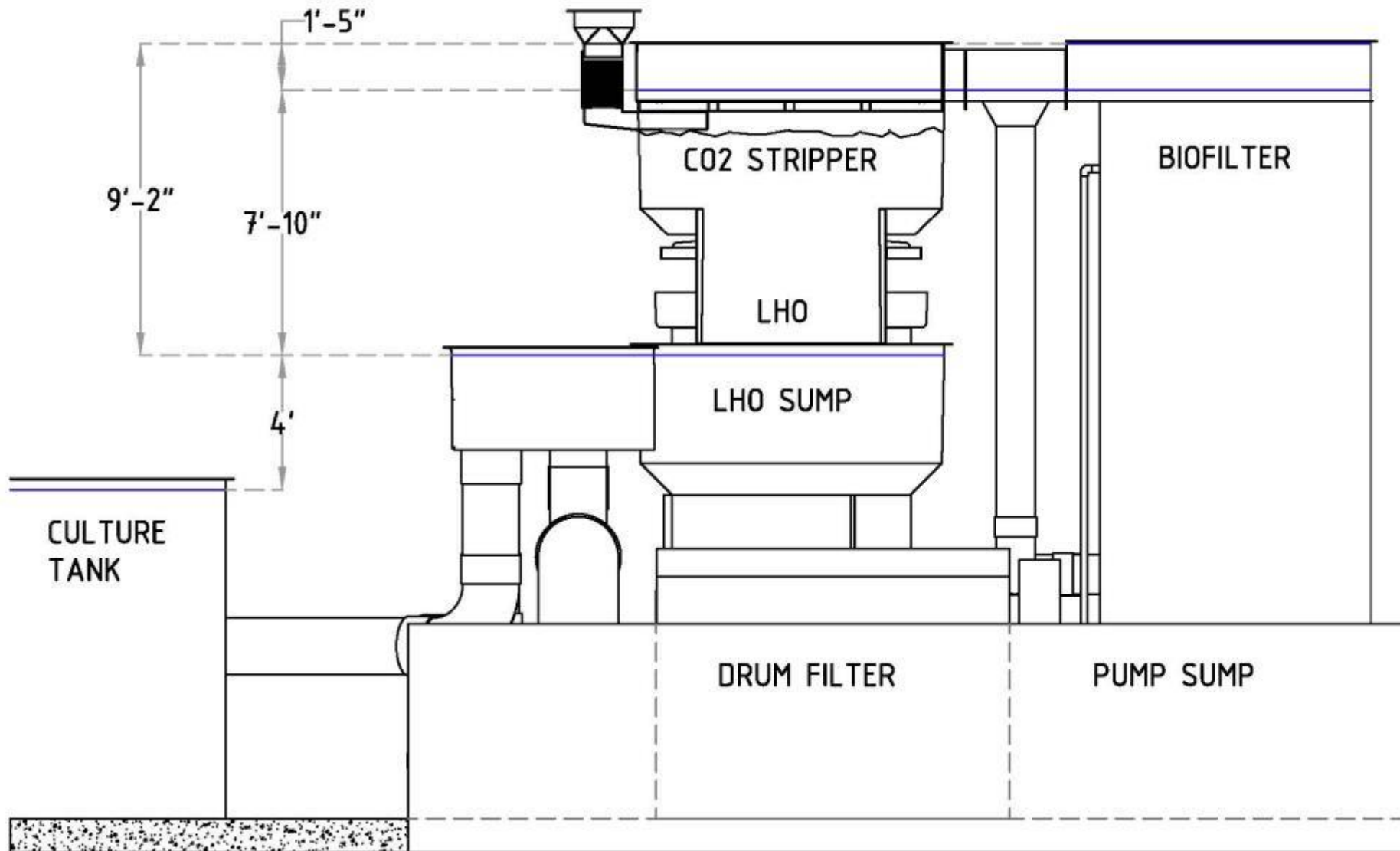
24-hr light and feeding every 2 hrs

CO₂ Production & Removal

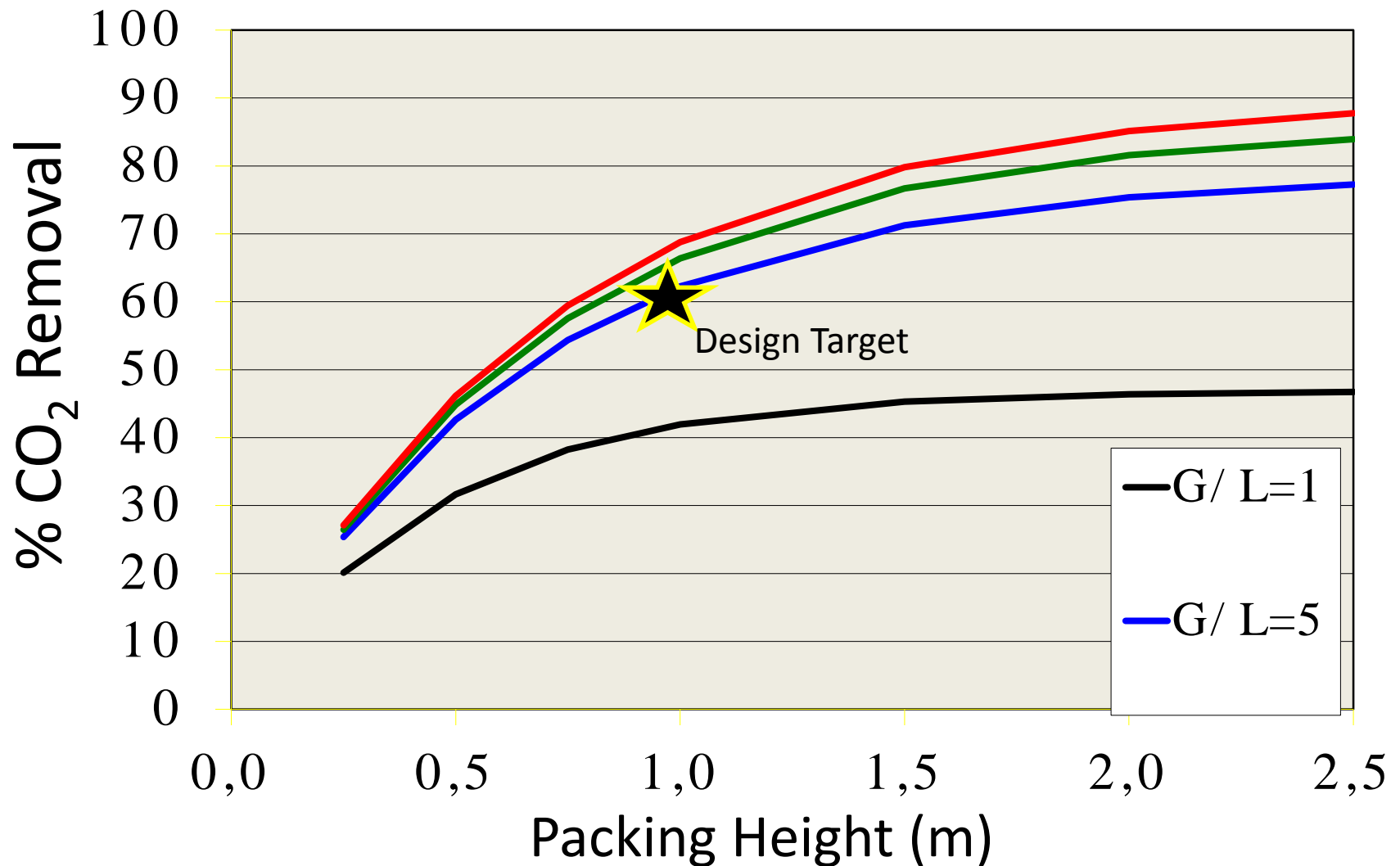
- CO₂ produced in culture tank & biofilter
- CO₂ removed during plunge into sidewall box



CO₂ Stripping Across Gas Balancing Unit



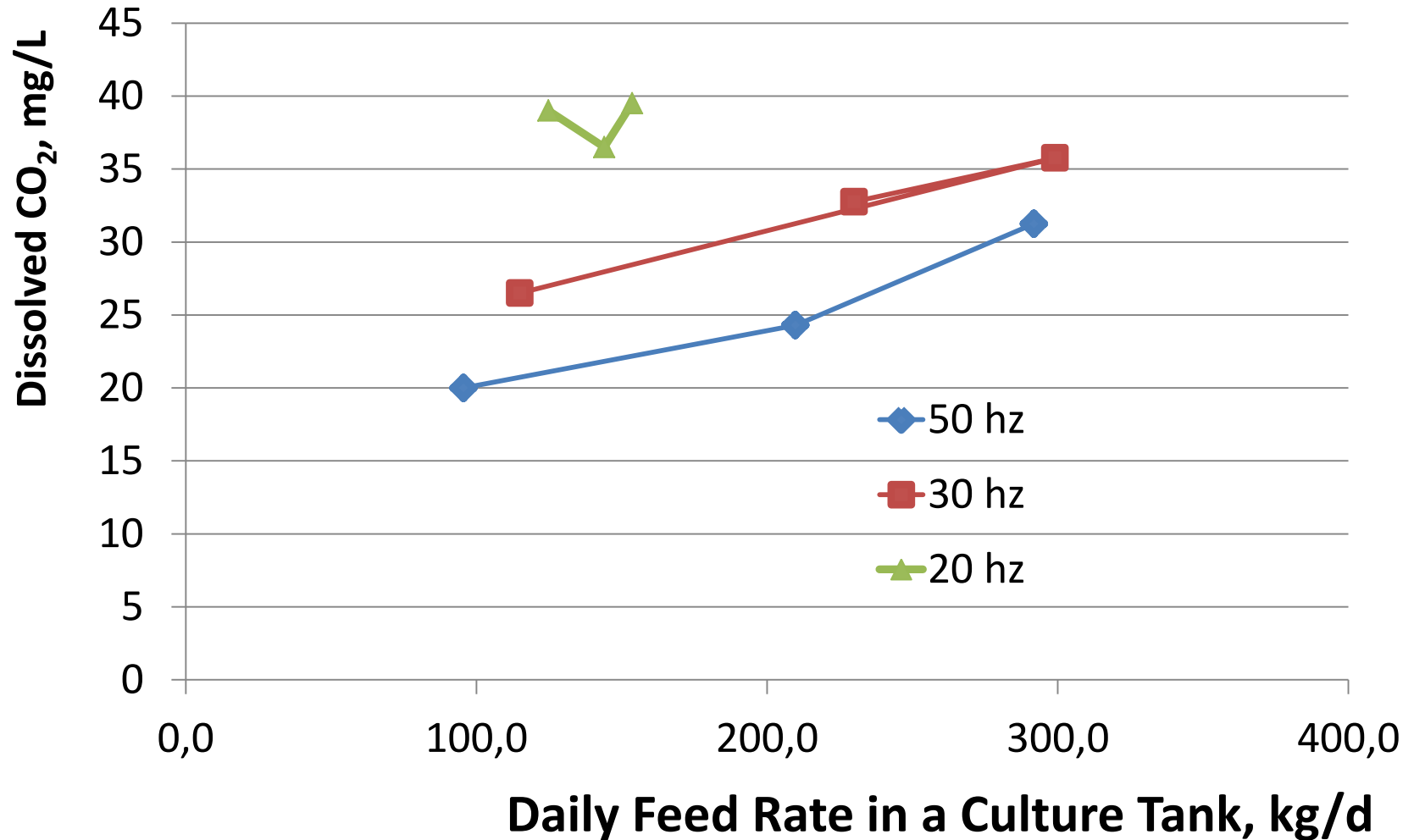
CO₂ Stripping Depends on Packing Height and Air:Water (G:L)



Ventilation Fan on CO₂ Stripping Column

- Variable Frequency Drive (VFD) used to adjust fan motor speed and air flow ventilated through stripping columns in each RAS
- Observational data collected from all tanks in two identical RAS modules
 - fan speed adjusted using VFD to three set-points
 - 20, 30, & 50 hz
 - 15.5°C water temp
 - 1300 to 1500 ppm CO₂ in room air

Culture Tank CO₂ Depends on Daily Feed Load and Fan Speed



Culture Tank CO₂ Depends on Daily Feed Load and Fan Speed

- Feed and Fan Speed significantly affect CO₂ in the culture tank (ANCOVA, P < 0.01)

	Fan - 50 hz	Fan - 30 hz	Fan - 20 hz
Feed, kg/d	CO ₂ , mg/L	CO ₂ , mg/L	CO ₂ , mg/L
150	22	28	38
200	25	31	NA

- CO₂ stripping across cascade aeration column
 - 45±1% at 50 hz
 - 24±1% at 30 hz
 - Not measured at 20 hz (but very little stripping)
- 15± 6% CO₂ stripped across sidewall box plunge

Air Ventilated out the Stripping Column Impacts Requires Energy

Control Strategy:

Set VFD on CO2 stripper exhaust fans to achieve target CO2 removal.

The associated makeup air units are ran from a building pressure controller. Maintain building pressure neutral to slightly negative.

Air Ventilated out the Stripping Column Significantly Affects Energy

- CO2 Exhaust fan energy in Row 3*
 - Full Capacity-81,000 cfm (60hz)= \$29,025 Yr
 - 85% Capacity-68,850 cfm (51hz)= \$17,760 Yr
 - 55% Capacity-45,000 cfm (33hz)= \$6,450 Yr
- Associated Makeup Air Cost in Row 3*
 - 100% 69,000 cfm= \$226,500 Yr
 - 85% 58,522 cfm= \$192,000 Yr
 - 55% 38,250 cfm= \$125,000 Yr
- Based on ASHRAE weather bin data for Fort Wayne, IN.; \$0.07 kWh electric rate; \$0.90 therm NG rate; water set point 15 C; Room set point 15.56 C

Design Conclusions

- Ventilation fans must operate near full-speed to control CO₂ at 25 mg/L in culture tanks when a tank is operated at \approx 200 kg/d feed
 - Reduced air flow creates problems at high feed load
 - Air flow can be reduced to save energy when tank CO₂ levels are below 25 mg/L
 - Real time monitoring of pump sump CO₂ concentration could be used in a feed-back control loop to adjust ventilation rate to minimize building air exchange

Design Conclusions-Energy

- Even small reductions in exhaust rates can have significant influence on operational costs.
 - VFD's are essential on the CO2 stripper exhaust fans and on the makeup air units.

Thank You!

