Micro-Nano Bubbles

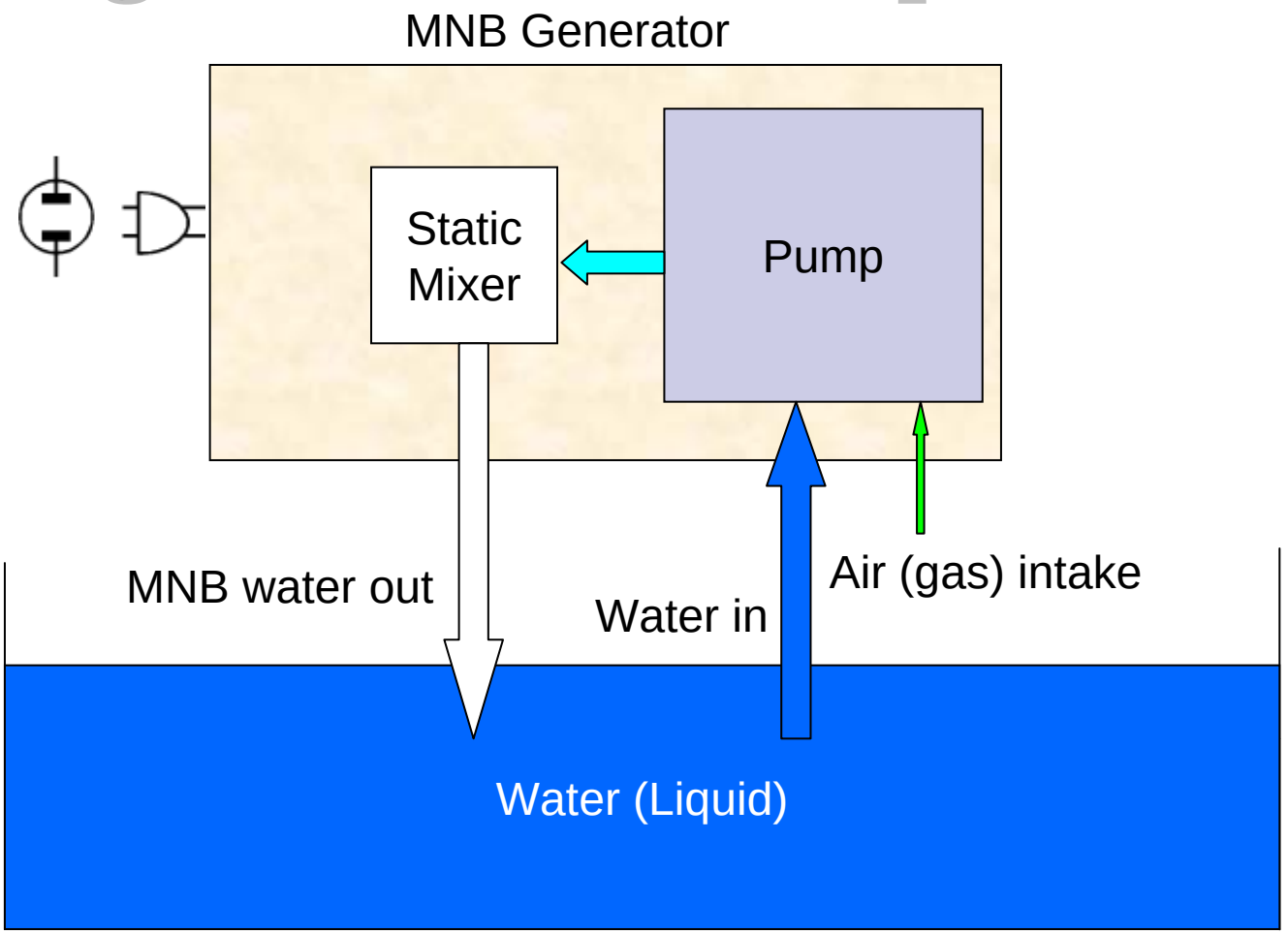
Current status

- The application development using Micro-Nano Bubbles (MNB) is in the early stage.
- Many studies have been carried out on aeration and sterilization.
- MNB technology has mostly been used in aquaculture and agricultural areas and other application developments are in progress.

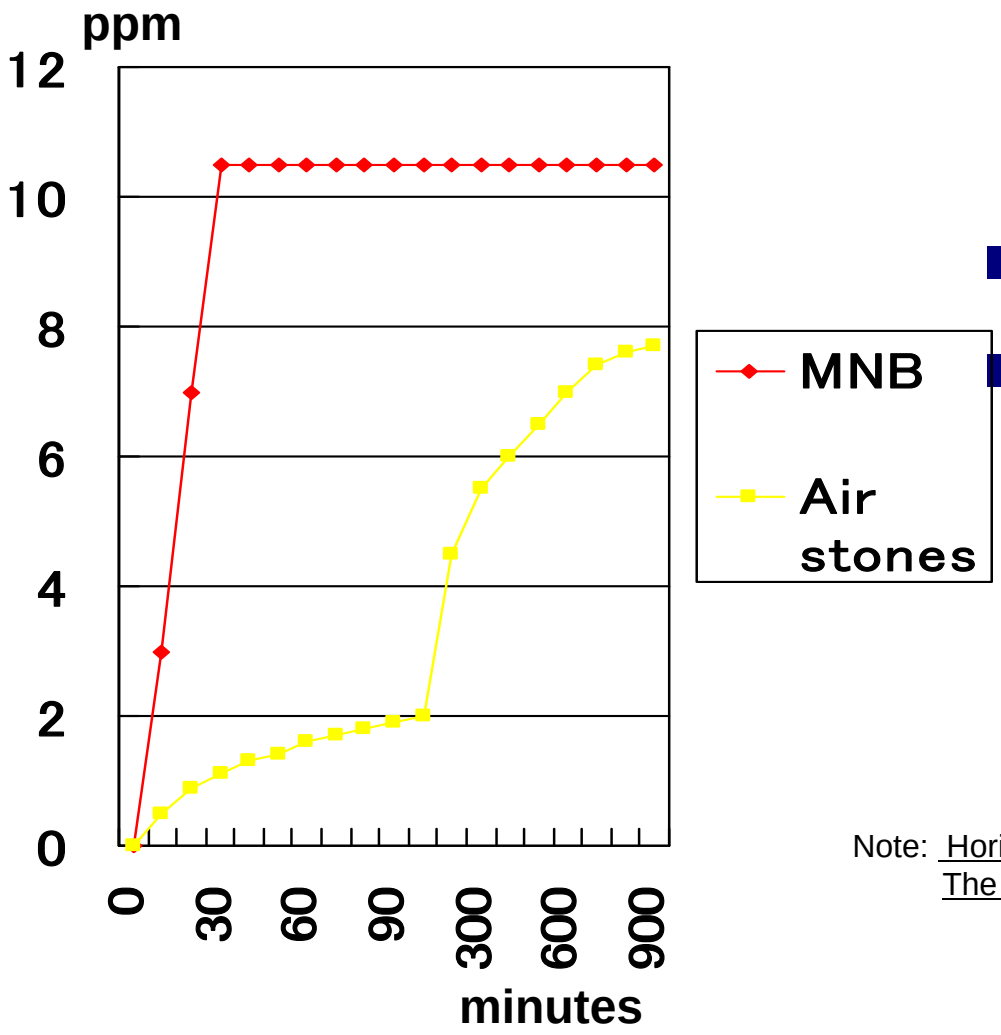
MNB Characteristics

- Large surface area
  Effectively transfer gasses (into and out of liquid)
- Slow rise time
  Floats like smoke
- Bubbles smaller than 50 micron shrink
  High inner pressure
- Micro-Bubbles break into Nano-Bubbles
  Stay for a long time
- Negatively charged surface
  Would not merge to make larger bubbles

MNB generator basic operation



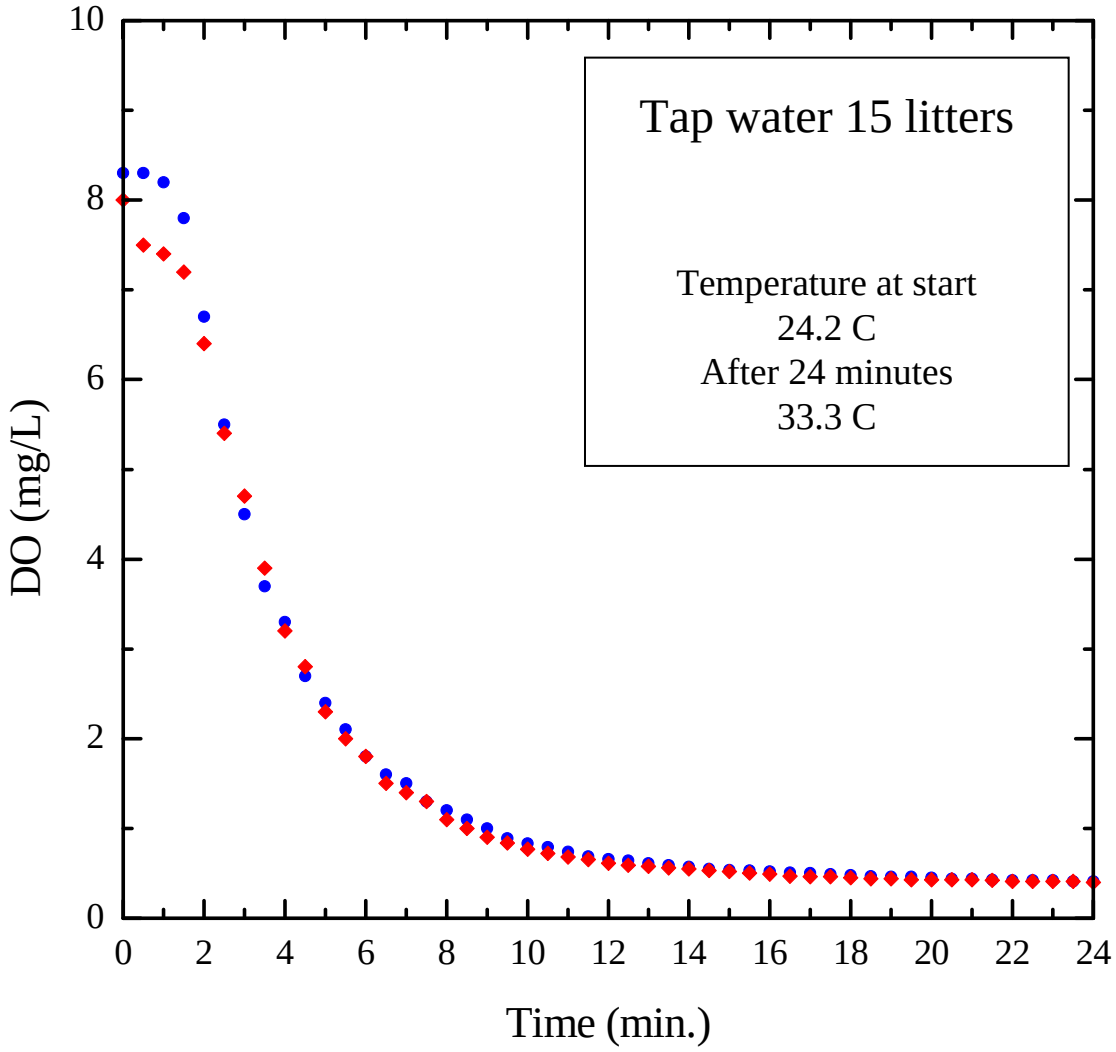
Oxygenation efficiency



- 10 tons of water
- Air amount =7.5L/minute

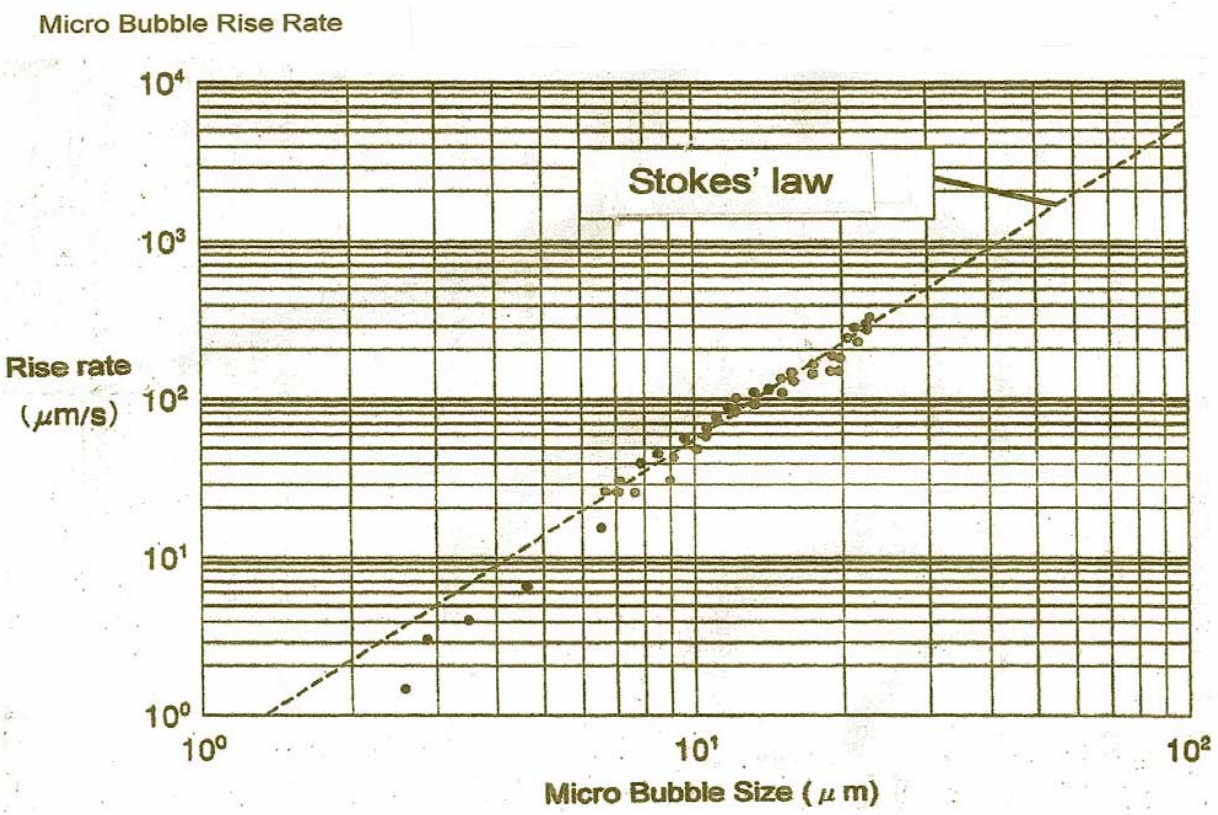
Note: Horizontal axis (Time) scale is changed at 100 minutes
The apparent DO jump on air stone is because of this.

DO decay with N2 using AS MK III

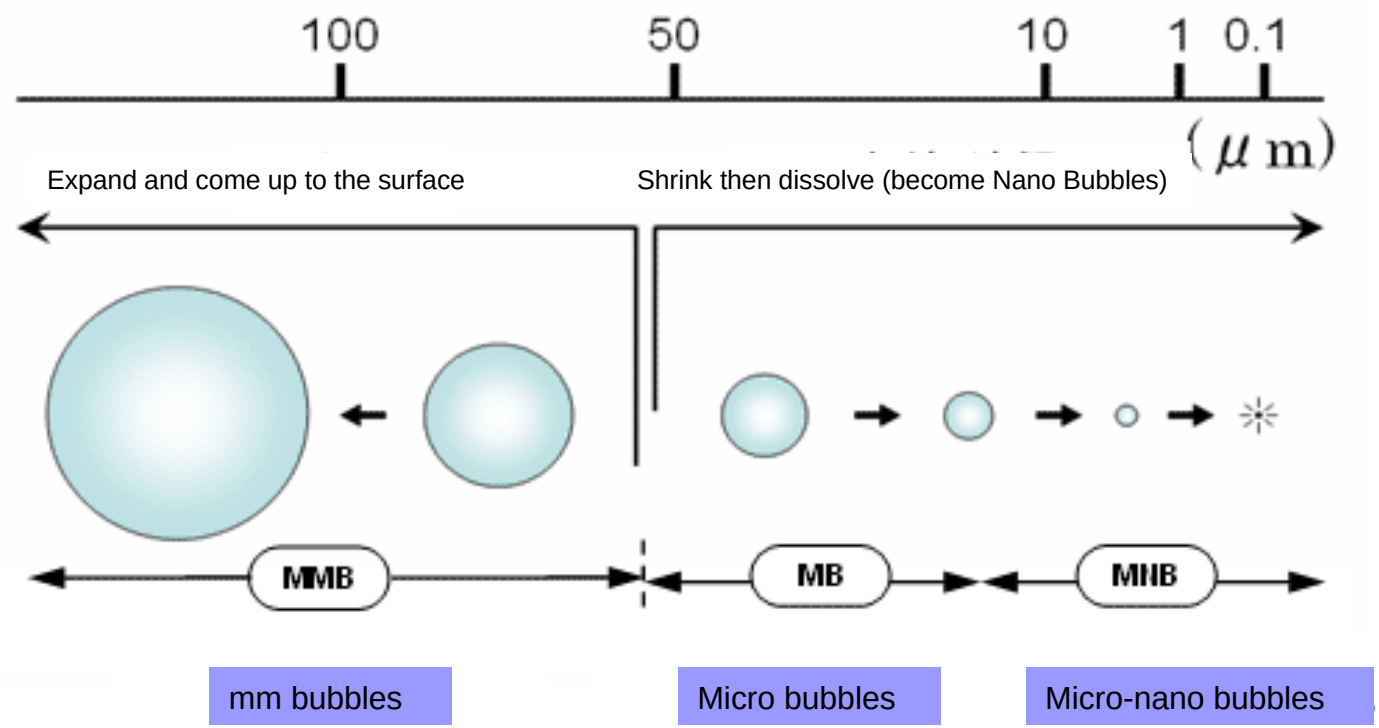


AS MK III
10 Liters per minute
MNB capacity
(0.4 L/min N_2)

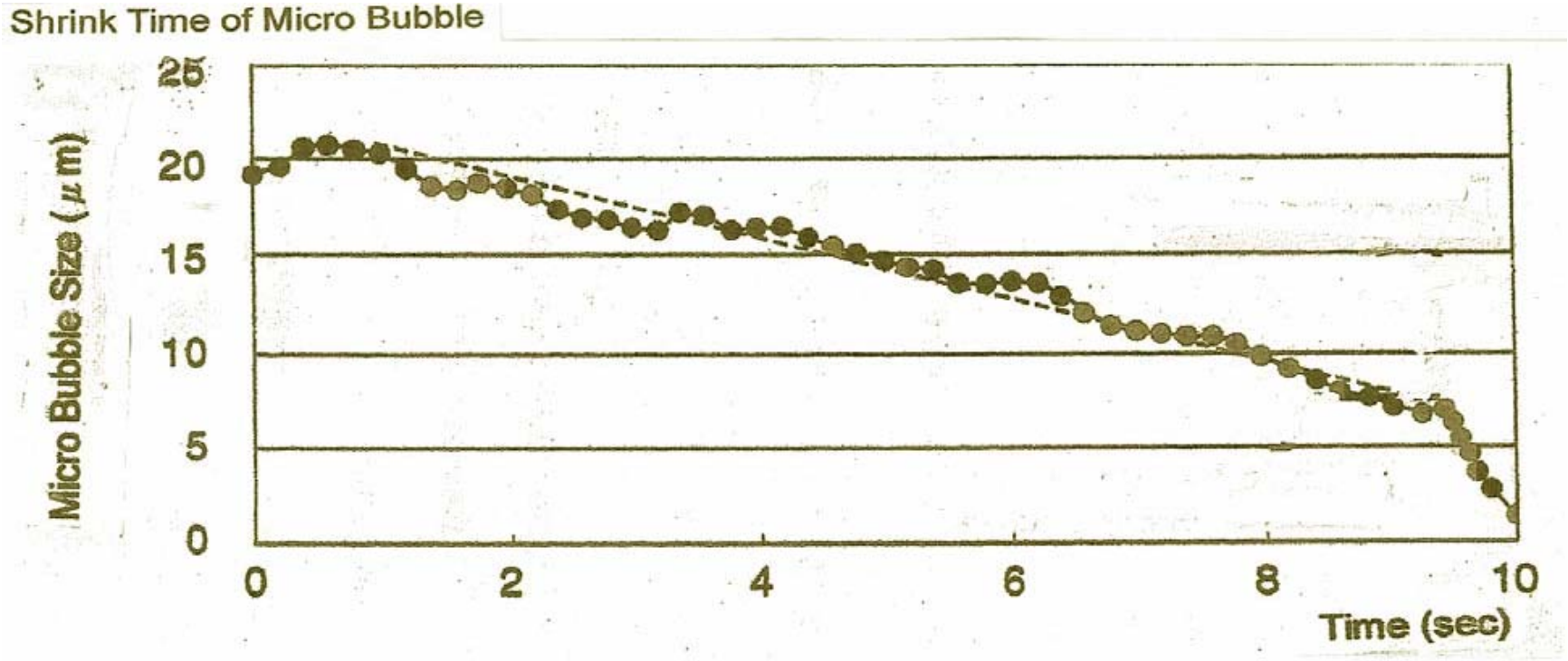
Slow rise rate of MNB



MNB less than 50 micron in size shrinks



Shrink time of MNB



Various possible applications

- **1. Oxygenation (Aeration) efficiency improvement**
  - Aquaculture, Agriculture, Hydroponics
  - Bio filtration, Bio reactor, Activated sludge system, Bio engineering
  - Reviving ponds, lakes and rivers
- **2. Dissolving other gasses effectively**
  - Ozone sterilization
  - CO_2 feeding, CO_2 beverages
  - O_2,H_2 rich drinking water
- **3. Cleaning ability improvement**
  - DAF (Dissolved Air Flotation), Protein skimmer, Fats-water separation
  - Use of less soap or chemicals in washing cleaning (general industry, food industry)
- **4. Other**
  - Fermentation
  - Making emulsion (Bio-fuel, etc.)
  - Medical, Dental (mouth washing after treatment etc.)
  - Reduction of friction for large ships to save energy
  - MNB bathing