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Aquaponics: Paradigm Shift with Airlift part 1

By

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Biography:

Aquaculture Specialist - Extension & Training
Human Nutrition Food & Animal Sciences Department (HNFAS)
College of Tropical Agriculture & Human Resources (CTAHR)
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http://www.ctahr.hawaii.edu/hnfas/individualPages/ron.html

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Biography:

2009 - 2012: Aquaculture Program Coordinator
Office of the Vice Chancellor
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2003 - 2008: Department Head, Genetics and Physiology, NCM-IOLR
1996 - 2003: Department Head, Physiology, NCM-IOLR
Visiting Professor at the Hebrew University of Jerusalem
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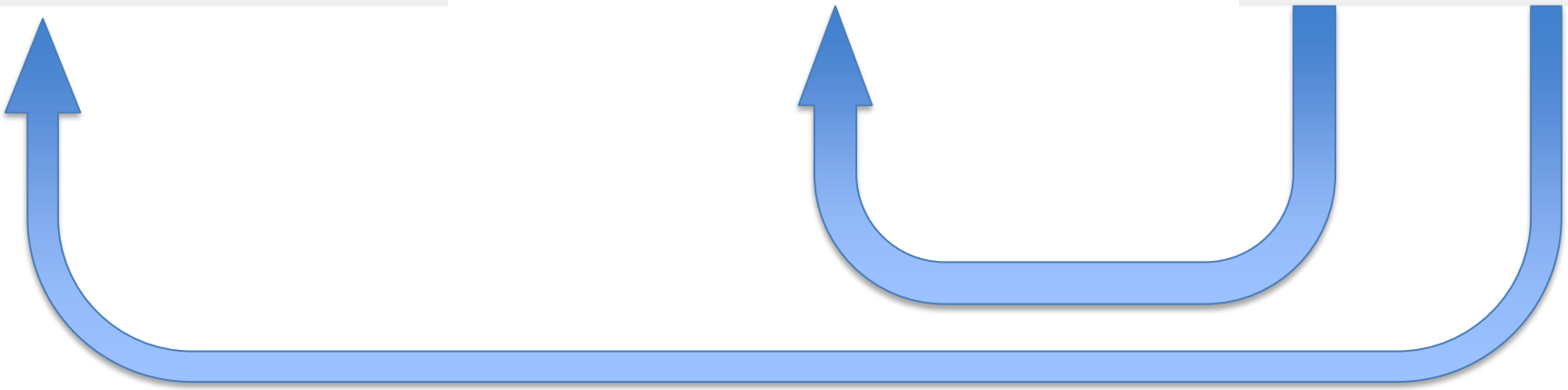

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Aquaponics: Paradigm Shift with Airlift

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Why Airlift Pump?

American Samoa October 2011

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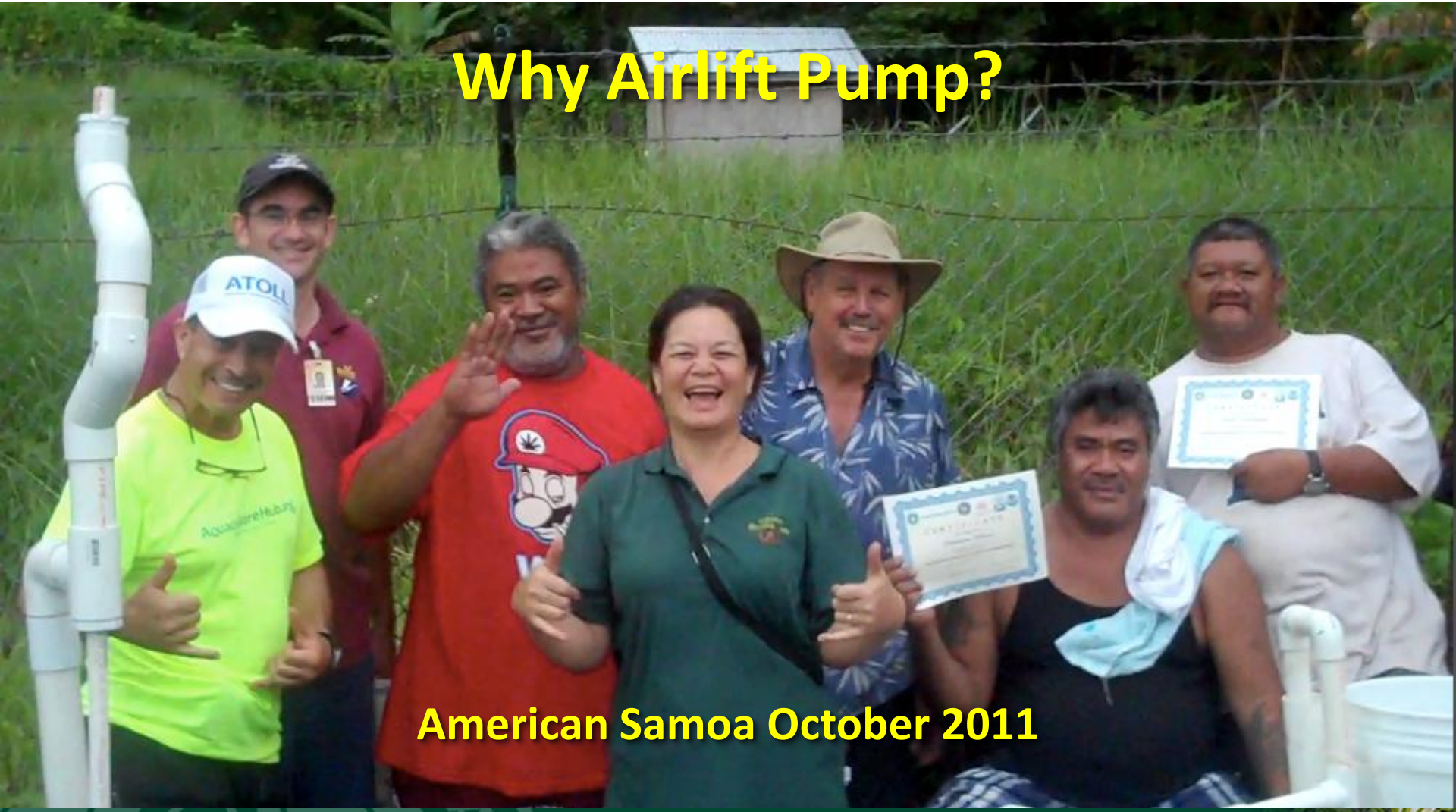
Why Airlift Pump?



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What is an Airlift Pump?

An airlift pump is a gas lift pump which is powered by compressed air
Airlifts are used in cases where light suction is needed

Cahoon, LB; Lindquist, DG; Clavijo, IE; Tronzo, CR (1992) In: Cahoon, LB. (ed.) Proceedings of the American Academy of Underwater Sciences Twelfth Annual Scientific Diving Symposium "Diving for Science 1992".
http://en.wikipedia.org/wiki/Airlift_pump

Inventor:

- The first airlift pump is considered to be invented by the German engineer Carl Emanuel Löscher (de), who lived in the second part of the eighteenth century. He discovered the airlift pump in 1797.

The Principle by which Airlift Pump is Operating:

- The only energy required is provided by compressed air
- This air is usually compressed by a compressor or a blower.
- The air is injected in the lower part of a pipe that transports a liquid.
- It usually bubbles into another larger diameter pipe.

The Principle by which Airlift Pump is Operating:

- By buoyancy the air, which has a lower density than the liquid, rises quickly.
- By fluid pressure, the liquid is taken in the ascendant air flow and moves in the same direction as the air.

The Principle by which Airlift Pump is Operating:

- The calculation of the volume flow of the liquid is possible thanks to the physics of **two-phase flow**.
- Airlift pump technology is superb due to its simple structure.

Two-phase flow:

- In fluid mechanics, two-phase flow occurs in a system containing gas and liquid with a meniscus separating the two phases.
- Two-phase flow is a particular example of multiphase flow.

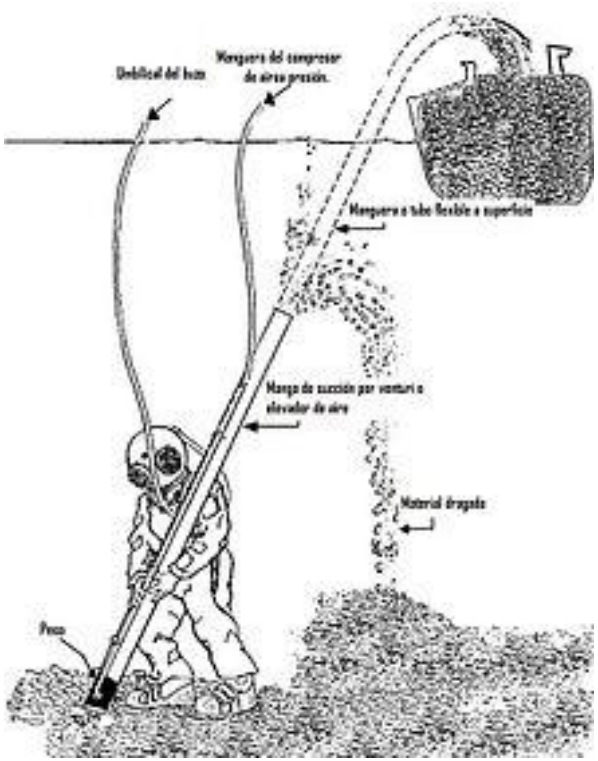
Examples and applications:

- Coal and gas-fired power stations used very large boilers to produce steam for use in turbines
- Nuclear reactors use water to remove heat from the reactor core using two-phase flow.

Examples and applications:

- bubbles, rain, waves on the sea, foam, fountains, mousse, cryogenics, and oil slicks.

Examples and applications:



However, it can have the following weaknesses:

- 1) Weak suction
- 2) Unstable flow rate
- 3) Frequent clogging
- 4) Difficult flow control
- 5) Low lift

Examples and applications:

- Coal and gas-fired power stations used very large boilers to produce steam for use in turbines
- Nuclear reactors use water to remove heat from the reactor core using two-phase flow.

Disadvantages:

- 1) cost: quantity of air to compress is high compared to the liquid flow required.
- 2) Conventional airlift pumps have a flow rate that is very limited. The pump is either on or off.
- 4) The suction is limited.
- 5) This pumping system is suitable only if the head is relatively low.
- 6) Because of the principle, a lot of air remains in the liquid.

However:

- "With thoughtful design, appropriate maintenance, and effective management, airlift pumps may allow the transfer of water through an aquaponics system in a more efficient way than using water pumps. Understanding the disadvantages and learning how easy it is to construct an airlift pump can help many to reduce their energy cost while avoiding the high risk and maintenance resulted from having a submerged electrical pump in the fish tank,"

Advantages:

- 1) The pump is very reliable.
- 2) The liquid is not in contact with any mechanical elements.
- 3) Act as a water aerator and can in some configurations lift stagnant bottom water to the surface (of water tanks).

Design Improvements:

- A recent (2007) variant called the "geyser pump" can pump with greater suction and less air. It also pumps proportionally to the air flow, permitting use in processes that require varying controlled flows. It arranges to store up the air, and release it in large bubbles that seal to the lift pipe, raising slugs of fluid

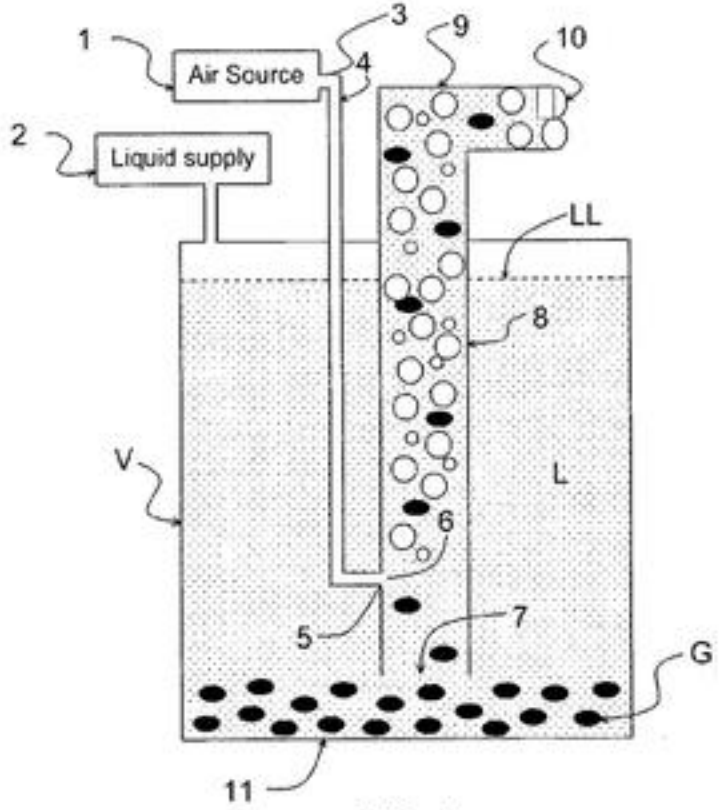


FIG. 1
US 2007/0166171 A1

An airlift pump, powered by compressed air, raises fluid by entraining gas to reduce its density. 1. Air supply. 2. Liquid supply. 3. Air inlet port. 4. Air supply line. 5. Air port. 6. Air outlet. 7. Fluid intake. 8. Riser tube. 9. Air liquid mixture. 10. Pump outlet. L:Liquid, usually wastewater. LL:Liquid level. V:Vessel G:Gravel or solids.

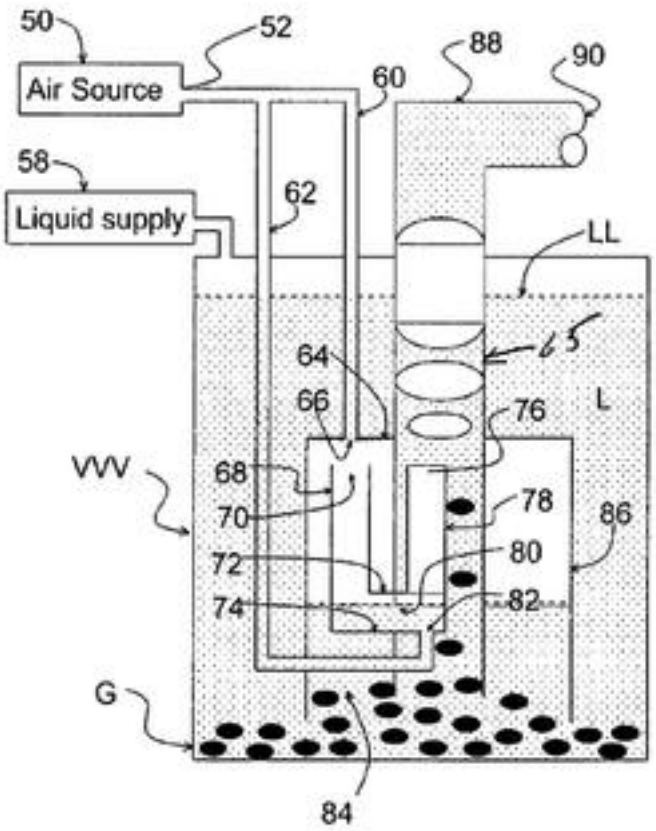


FIG. 7
US 2007/0166171 A1

A geyser pump, an improved airlift pump, powered by compressed air, raises fluid by forcing rising bubbles to displace fluid. 50. Air supply. 52. Air inlet port. 58. Liquid supply. 60,62. air supply lines. 64. upper end of air tank 86. 66,82. Air ports. 70. Upper air inlet of u-shaped elbow 74. 76 Air outlet. 84. Fluid intake. 65. Riser tube. 88. Displaced liquid. 90. Pump outlet. L:Liquid, usually wastewater. LL:Liquid level. VVV:Vessel G:Gravel or solids

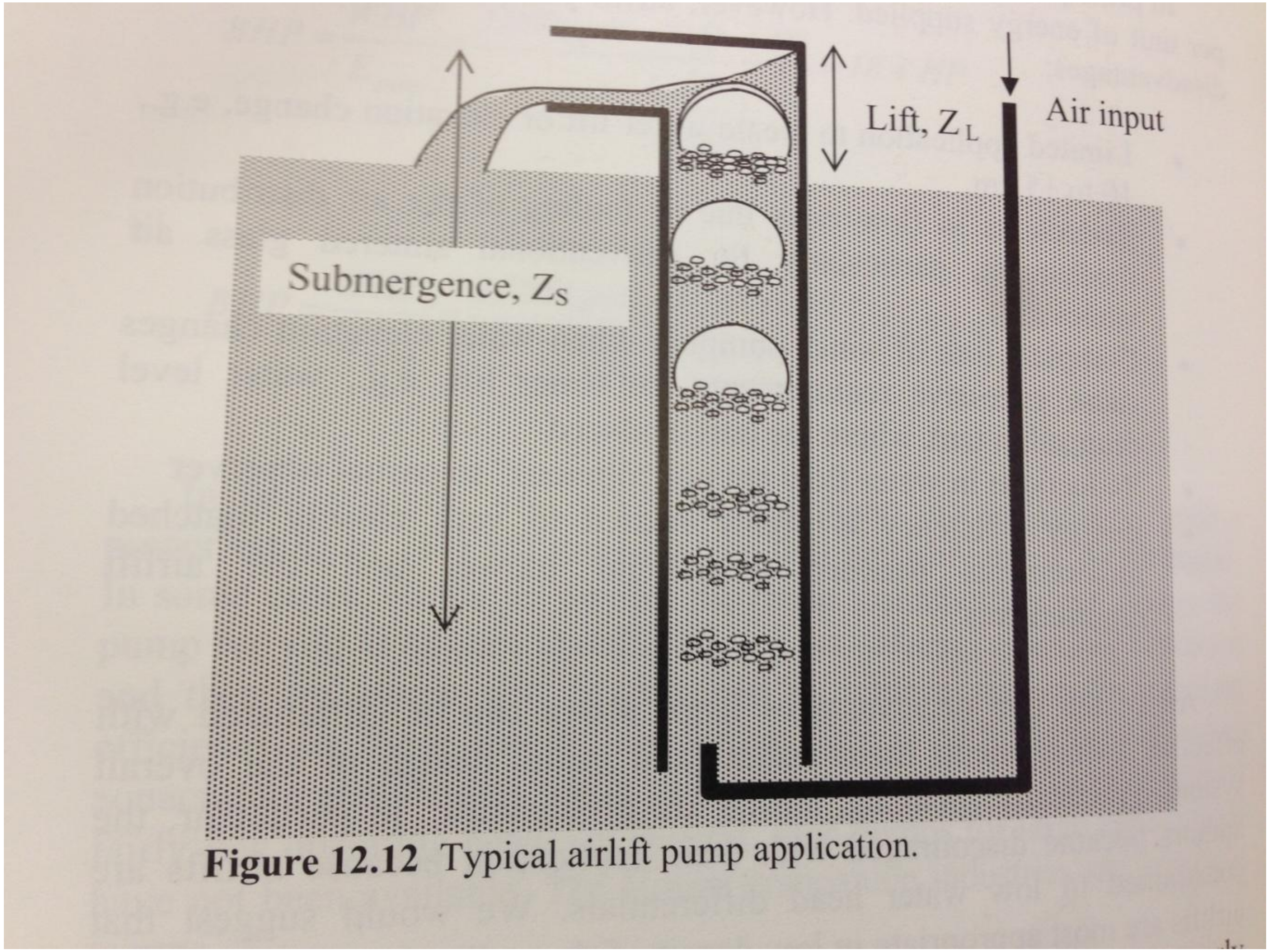


Figure 12.12 Typical airlift pump application.

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regime occurs in tubes with diameter greater than 25 mm (1 inch) when the gas void ratio is above about 25% regardless of the initial bubble size.

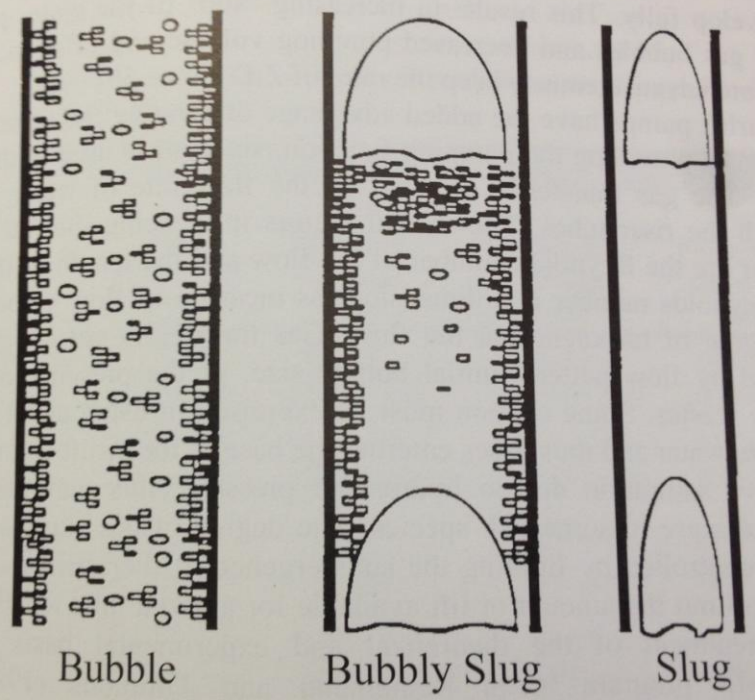
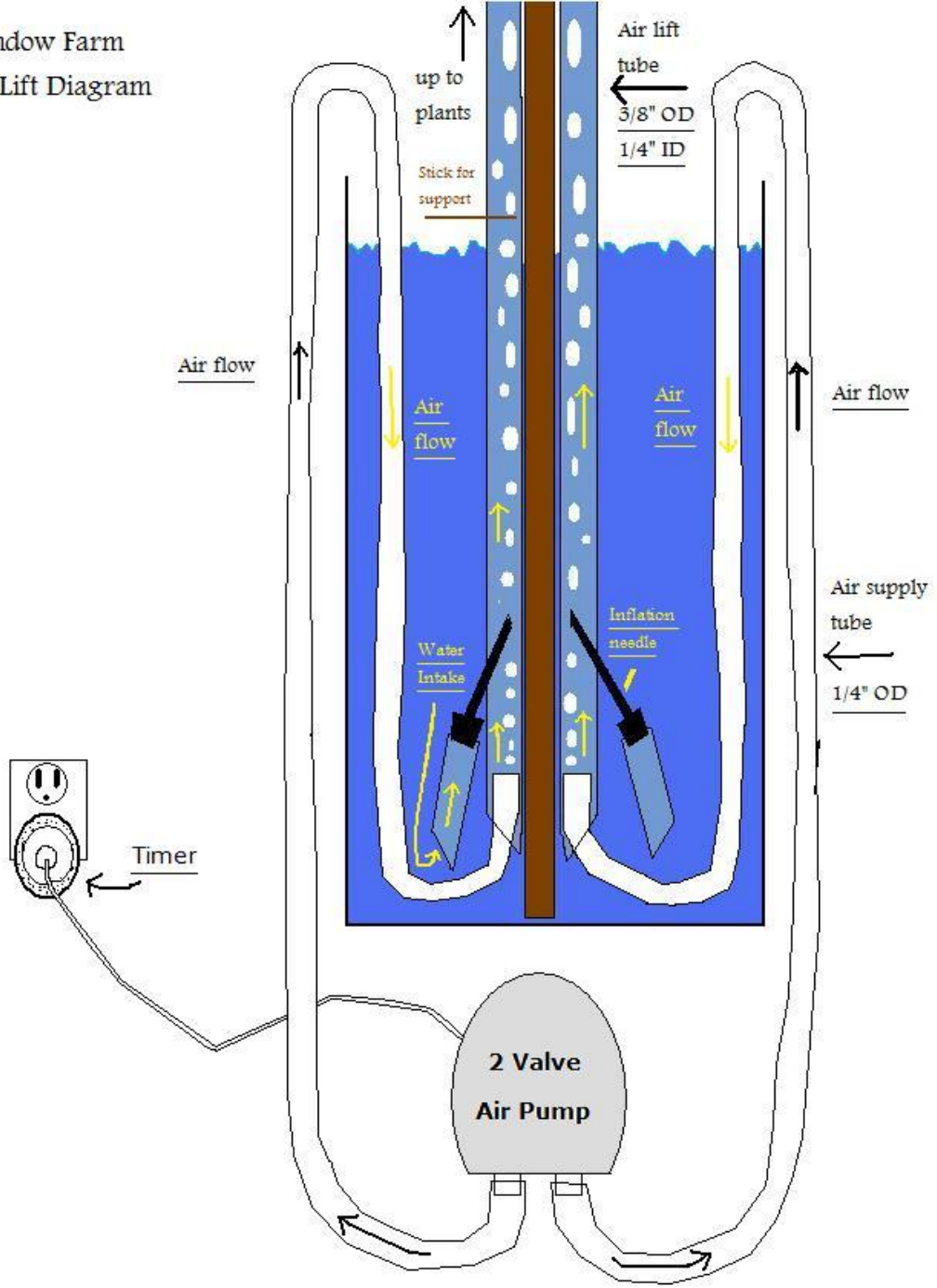


Figure 12.13 Three flow patterns encountered in airlift pump operation.

The gas concentration in the tube is a function of the submergence

Timmons and Ebeling, Recirculating Aquaculture

Window Farm
Air Lift Diagram

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