Crab and Lobster Live Holding System
Part II (Water Pumps, Air Pumps and Pipework)

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The increased demand for crabs and lobsters, and the requirement to export live shellfish has led to the Industry needing better methods and information about live holding. This data sheet is part of a new series forming a guide to the selection of equipment needed to successfully store and transport live crabs and lobsters. These data sheets should be used in conjunction with data sheets produced in 1987: Handling Crabs for the Live Trade. Parts I and II. This sheet provides a guide to the selection of water pumps, air pumps and pipe work.

Water Pumps

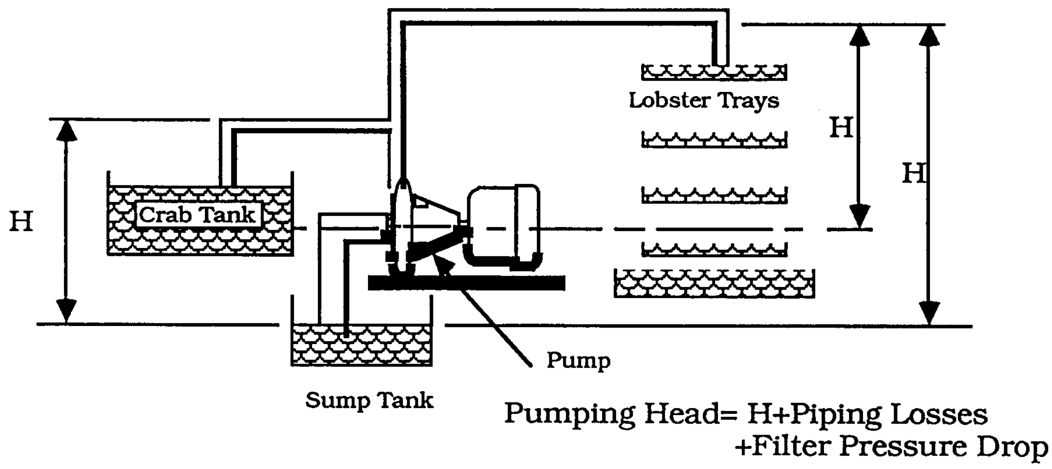
The duty requirements of pumps in live holding systems is usually to provide large flows at low heads (low pressure).

If water is being taken from a clean seawater source which is at a distance from the holding tanks then the pumps will have to lift the water from low tide levels and overcome the resistance of long pipe runs. The pump should be sited as near to the water source as possible and should be of the self priming type. Note that even a `self priming' pump will need to be filled with water before its first run.

The centrifugal type pumps are well suited to working as circulating pumps. They have a low initial cost and are easy to maintain. The all plastic swimming pool type are ideal, these are usually manufactured in glass fibre or polypropylene (PVC is not recommended for aquaculture purposes). Other types of industrial pump of all plastic construction can be used. Pumps using magnetic drives are good for use with salt water as they have no shaft seals; this eliminates the possibility of leakage but they are more expensive than the conventional type. Most centrifugal pumps do not like running dry and the pump should be sited such that it is always flooded.

The flow performance of the pumps required will depend on the number of tanks it is servicing. The usual requirement is for the water in the tanks to be changed 4 times per hour. If the crabs occupy one quarter of the volume of the tanks the pump will then have a delivery of three times the volume of the tanks per hour at a head equal to the distance from the centre line of the pump, or the water surface of the sump tank, to the highest point in the system (Fig. No. 1). When long pipe runs are involved allowance will have to be made for this. For an average system with 4 to 6 holding tanks the addition of 2 to 3 metres head to the pressure requirement should be sufficient. In the case of lobster holding trays with short pipe runs 0.5m head to cover valves and pipes should be sufficient. Where pressure filters are used the pressure drop through the filter must be added to the other back pressure values to calculate the performance of the pump. Filter manufacturers can supply information on pressure drops through their equipment.

It may be where large lifts are involved that a submersible pump is the best solution. If suction lifts greater than 8.25m are envisaged a submersible pump must be used.



PUMPING HEAD **Fig No1**

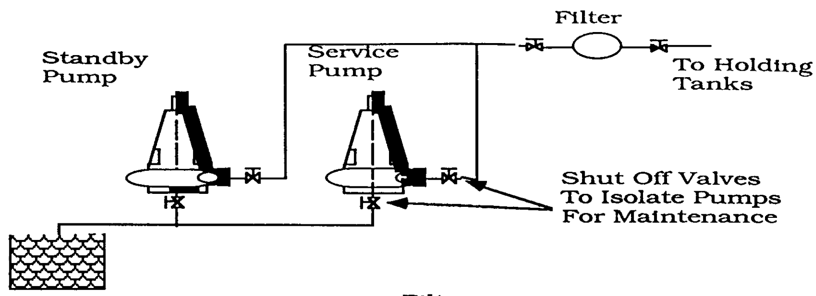
The power consumption of pumps can be found the manufacturers' technical data sheet. A reasonably accurate figure can be calculated from the formula:-

Power in Kw + $\frac{P.Q.H}{367.N}$

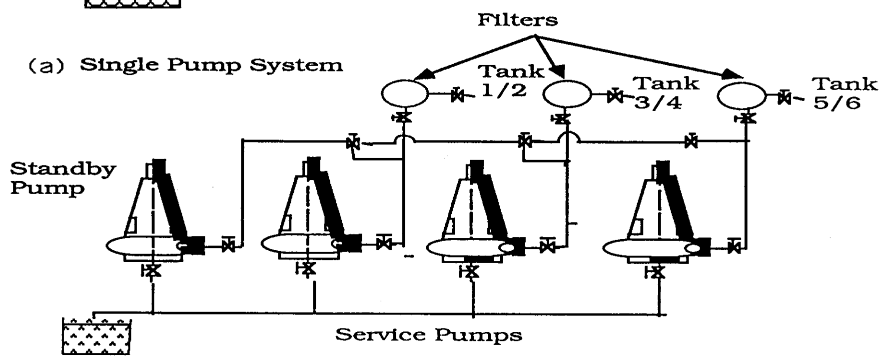
where P = Density (for water use 1).
Q = Flow M^3/h
H = Head (Pressure) metres
N = Efficiency (an average value of 0.7 will give reasonable results)
376 = Conversion factor (constant)
1 Horsepower = 0.745 KW

This figure for power can be used directly if calculating power consumption costs but if used for calculating motor size than add 20% for powers up to 7.5 Kw and 15% from 7.5 to 40Kw. This will give a safety margin for changes in service conditions.

It is advisable to have back up pumps in the system in order that should a pump fail a reserve pump can take over its duties while repairs are effected (Fig. No.2).

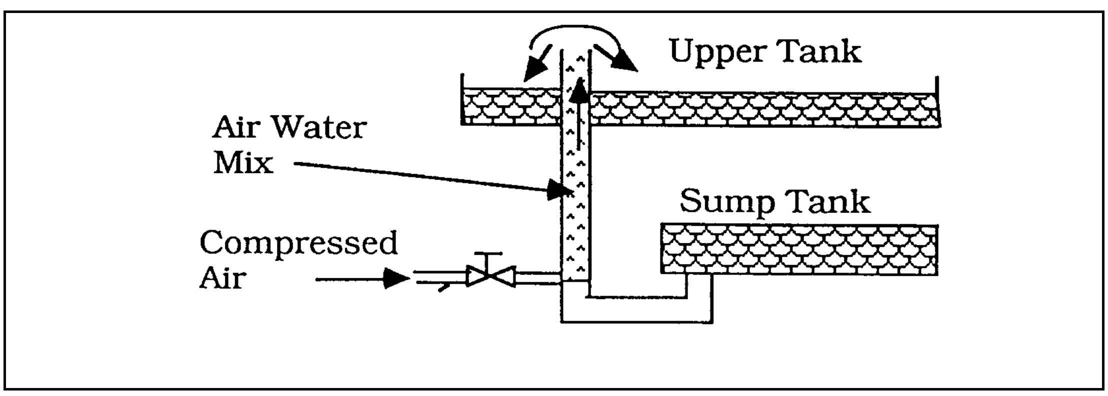


(a) Single Pump System



(b) Multi Pump System

Air lift pumps can often be used to circulate and aerate water in small systems. A small compressor, which must be of the oil free type, can be used to circulate and aerate water. The airlift pump uses a mixture of air and water to cause water to rise up a pipe (Fig. No.3). Limited design data is available for this type of pump but starting with a 25mm diameter pipe experimentation with air flows will be required to get the required lifts. Approximately 0.6m^3 free air will lift 100 litres of water 3 metres.



Pipes for Circulating Water

As was indicated in the section on water pumps the water being circulated in a live holding system is at a low pressure and in relatively large volumes. This is a situation which lends itself to the use of plastic piping. Material such as Copper, Brass or Bronze Zinc plated metals, and some alloys of stainless steel are mildly toxic and must be avoided.

There are several makes of plastic pipe that can be used. ABS, Polypropylene and Polyethylene are suitable, but pipes of uPVC are not generally recommended for recirculating systems. Because of the low pressures involved the thin walled pipe can be used. Class B or C are satisfactory. Thermoplastic pipes expand more than metal with changes in temperature and this has to be allowed for when planning pipe runs and in pipe fixing. The piping manufacturers will usually supply data sheets giving design and installation information.

Pipe sizes can be determined for the expected water flow rates. For pipes on the suction side of the pump the water flow in the pipe should not exceed 0.5 to 1.5m/sec (the higher the suction lift the lower the design water speed), while for pipes on the pressure side the water flow should not exceed 2 to 3m/sec (using the lower figure for long pipe runs). The table below gives a guide to pipe sizes in typical installations.

Table No.1

Flow m3/hr	Pipe Size		No. of 1.5 x 4m Crab Tanks
	Suction	Delivery	
18	90mm/3in	63mm./2in	1
36	123mm/5in	90mm/3in	2

72	200mm/6in	140mm/5in	4
108	225mm/8in	60mm/6in	6
144	280mm/10in	200mm/8in	8

Nominal Pipe Sizes

Based on 1m/s Suction Velocity & 2m/s Delivery Velocity
Class C---- 10 Bar Pipe

Aeration Systems

Where clean fresh seawater is being used without being recycled it is often not necessary to provide additional aeration. Check on the dissolved oxygen levels in the tank close to and in the drain line. Low levels indicate external aeration is required.

With lobster trays in aeration system is not usually required as the cascading of the water from each tray has the effect of re-oxygenating the water. Water falling approximately 300mm will have the effect of raising the dissolved oxygen level.

Air Pumps

Where there is a requirement for aeration the type of pump used should have a large volume delivery of air at a low pressure and should delivery clean oil-free air. Air pumps should be located in an area where they cannot take in exhaust gases or pollutants from other machinery.

Side Channel Compressors are well suited to this application. If very large airflows are required – over 430m^3/h – a Roots type blower may be more appropriate. As with the water pumps it is advisable to have a standby air pump in case of failures. The size of compressors required will depend on the number of tanks they are supplying.

Where diffuser air stones or porous pipes are being used the manufacturers' specifications must be consulted for air supply requirements. A satisfactory aeration system can be fabricated by drilling 3mm diameter holes on approximately 100mm centres in plastic pipes laid in the bottom of the tanks. This pipe work will need protection and this can be achieved by almost burying it in the floor of the tank (see Data Sheet Part I) so that only the top of the pipe is exposed, or by laying a protective grid over it. Table No.2 gives a guide to the compressors and pipe sizes that can be used with this type of system.

Table No.2
Table 2 is based on 35m pipe run with 3mm diameter aeration holes in the pipework in the tanks

Power Kw	No. of 1.5 x 4 Tanks	Main Pipe Diameter mm	No. of Holes at 1m Water Depth
0.5	1.0	63.0	150.0
1.2	2.0	75.0	300.0
1.4	4.0	110.0	600.0

Air Compressor and Pipe sizes

Airline pipes are manufacturers in special grades of ABS. They are easy to install and very tough. Like ABS water pipes the air pipes have a high rate of expansion when subject to temperature change. Pipe clips and runs should be designed with this in mind.

Water Temperature

It is helpful if the water is maintained at a temperature of around 10^{o}C. This is important for the well being of the animals, and water is better able to hold dissolved oxygen at lower temperatures. Rapid changes in temperature are to be avoided. In recirculatory systms temperature increases can become a problem. If compressors supplying air to aeration systems operate at too high a pressure heat can be added to the water in this way.

It is possible to use spare refrigerating capacity from cold stores etc, to cool the air supply to aeration systems.

Chiller systems for water are available as packages. The exact size of chiller required can be found from the manufacturers. The information the refrigeration engineer will require are volume of tanks, target temperature of tanks, volume and temperature of any make up water, water pump powers, ambient temperature range and construction of the tanks (level of insulation). Table 3 gives a guide to the sizes of cooling unit that will be required.

Table 3
Guide to Power Requirements for Water Cooling

No of 1.5 x 5 m Tanks (Volume of Water)	Water Flow Rate m3/hr	Kw for Temp Drop Recirculating Tanks		Kw for Temp Drop Flow through Tanks
		5°C	10°C	5°C
1 ($6m^3$)	18	0.6	1.1	4.25
2 ($12m^3$)	36	1.1	2.2	7.5
4 ($24m^3$)	72	2.2	4.1	12.5
6 ($36m^3$)	108	2.6	5.6	15.4

Further Reading

MAFF Laboratory Leaflet No.37 - The Live Storage of Lobsters
MAFF Laboratory Leaflet No.39 - Artificial Seawater for Shellfish Tanks
Design and Operating Guide for Aquaculture Seawater Systems - John E Huguenin and John Colt
Aquaculture Engineering - Fredrick W Wheaton