The 'Atakwa' incubator for bacteriological testing

Richard Brown, Tom P. Curtis and Andrew V. Metcalfe

This article describes the development of a simple, very low-cost incubator, heated without electricity, allowing bacteriological testing to be carried out virtually anywhere.

Community-based projects wishing to test water quality find that incubators are the most expensive item in the bacteriological testing of water (for example, the technically excellent Delagua kit costs US$1900). The construction materials for the incubator described here, however, can typically be found in any rural market town, thus significantly reducing the cost of the incubator.

The incubator was developed during a visit to Ecumfi Atakwa, a small rural village in Central Region, Ghana where we wanted to test the bacteriological quality of local water sources. The 'Atakwa' incubator was developed using locally purchased materials because an incubator was not locally available.

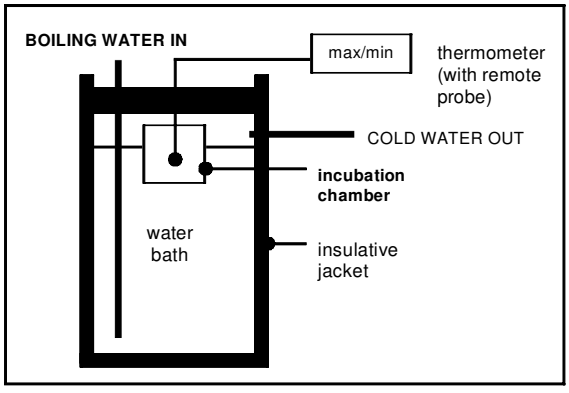
The first Atakwa incubator was built because no other incubator was available

What is the Atakwa?

The Atakwa incubator is simply an incubation chamber partially submerged in a water bath. The temperature of the water bath, and thus the chamber, is controlled manually. The bacteriological testing system requires:

- simple construction materials to make the incubator
- a thermometer (preferably max/min with a remote probe)
- bacteriological media, glassware and a means of sterilization.

Figure 1
Essential components of the incubator design



A schematic diagram detailing the key components of the incubator design is shown in Figure 1. The materials used for the first Atakwa incubator included a large plastic bucket (approximately 25 litres) to contain a water bath. Plastic inlet and outlet pipes were installed to allow boiling water to be added, and cold water displaced. A catering-size tin can was partially submerged in the water bath and used to contain the samples for incubation. The whole system was then surrounded with 100 mm thick foam matting.

How does it work?

The basic design principle is the same as that of any conventional incubator. The heat losses from the incubator to the surrounding atmosphere must be balanced by pouring predetermined amounts of boiling water into the water bath.

During validation work in Nepal, one litre of boiling water was added every three hours to maintain the temperature within a one degree range (43.5°C – 44.5°C). In one test two people kept the incubator running for a 48-hour period, and this was not considered too onerous. For low-cost testing in a community setting keeping the incubator topped up with

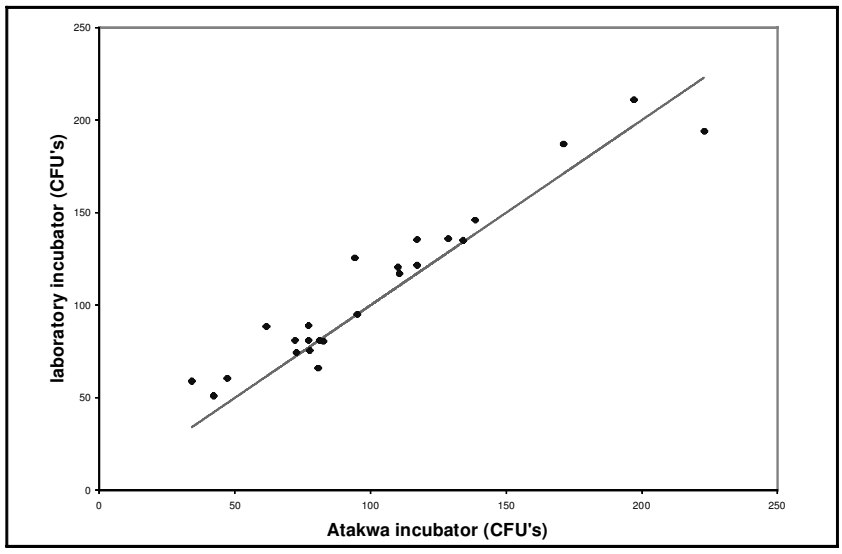


Figure 2
Plot of result pairs from laboratory and prototype incubators

boiling water ought not to be a problem.

Our work focused on assessing the effect of this varying temperature on the collected results.

System validation

We wanted to compare directly the performance of the Atakwa with standard laboratory incubators. The Ghanaian prototype incubator was reconstructed in a laboratory with cooling characteristics similar to those achieved in the field. Substituted material components included a standard domestic cool box, expanded polystyrene and plywood sheeting instead of a bucket, foam and parcel tape.

Initially it was hoped that the cool box alone would contain and insulate the water bath, but it did not, so the cool box was surrounded with 100 mm expanded polystyrene sheeting. A box was constructed to hold the system together.

Water samples were taken from the River Tyne, on eight occasions, and tested for thermotolerant faecal coliforms (using the Membrane Filtration technique[1]). On each occasion, six duplicate samples were prepared. Three were randomly allocated for incubation in the Atakwa incubator, with the other three being incubated in the laboratory incubator. The samples were incubated for 18 hours. The results of each incubation were an average of the coliform counts on two plates (referred to as 'counts' hereafter).

Since three duplicate samples were tested in each incubator on eight occasions the inherent variation in counts made on duplicate samples could be estimated for each incubator and compared. The possibility that one or other incubator gives systematically higher readings was investigated by analysing the 24 paired comparisons: that is, three comparisons of duplicate samples for each of the eight occasions.

Results and discussion

The laboratory incubator counts are plotted against the Atakwa incubator counts for the same sample in Figure 2. Ideally, the counts from the two incubators would be identical, in which case they would lie on the diagonal line in Figure 2, but there is inherent variation in counts obtained from either of the incubators and, perhaps, a systematic difference between them.

A statistical analysis of paired comparisons (based on the logarithms of the ratios[2]) gave a most likely value of 0.96 for the ratio of the Atakwa count to the laboratory incubator count, with a 95% confidence interval of 0.935 to 0.991. So, the Atakwa gives results that are estimated to be 4% lower on average, with 95% confidence that the Atakwa is between 1% and 7% lower on average. A 4% systematic difference is fairly small when compared with inherent variation of about 9% (standard deviation of replicates expressed as a percentage), and is, in any case, of little practical concern.

We are confident that, under similar test conditions, it is feasible to use the Atakwa incubator in place of a conventional one.

Quality testing by communities

Historically water testing has been used to help engineers and other public health professionals make decisions about water quality. However many other communities and institutions could benefit from this technology. For example, a programme in Kibwzi, Kenya involved a local committee in the bacteriological testing of well water and drinking water in the homes of well users.[3]

The Atakwa is particularly useful because it is cheap and simple: it could be easily set up in any village at around one hundredth of the cost of a commercial field incubator.

about the authors
Richard Brown and Tom Curtis are at the Department of Civil Engineering, University of Newcastle upon Tyne, UK, and Andrew Metcalfe is at the Department of Applied Mathematics, Adelaide University, Australia. Notes on the construction, calibration and operation of the Atakwa incubator are available by emailing: r.g.brown@ncl.ac.uk

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