Resource Development International Cambodia (RDIC)

Contact

Mickey Sampson / Marc Hall
PO Box 494
Phnom Penh, Cambodia
Phone: 855-23-369-577
mickey@rdic.org
marc@rdic.org

Summary

Resource Development International (RDI) is a faith-based NGO with bases of operation in Kean Svay and Siem Reap, Cambodia, although the reach of their programs is nationwide. RDI believes that its role is to provide resources to the development world as well as the developing world, a policy that is through their eagerness to share manufacturing details, marketing materials, and educational strategies.

RDI filters at a glance:

- Smooth, even-surfaced filter element
- 0.2-micron pore size
- 10L capacity
- 1.5-2.2L/hour flow rate
- Silver-nitrate painted (300mL total)
- Food grade, pigment-less plastic container
- Silver-impregnated ceramic tap

In raw costs, 1 ceramic pot costs about $1.00. At the factory, the ceramic pot is sold for $3.00. Below is a table of costs incurred per filter:

Item	*Cost in USD*	*Sale Price*
Water receptacle	$3.50	-
Spigot	$0.36	-
Ceramic Element	$1.00	$3.00
Threaded PVC connector	$0.10	-
Total	**$4.96**	**$8.00**

1 Water testing

RDI believes that water-testing is an essential component of creating and distributing quality products, as well as key to conducting follow-up research. Thus the lab they have established is the equal or better of any water-testing laboratory in the country. Testing is conducted in partnership with and on behalf of universities, local government, and other NGOs conducting research or testing. Past and current activities include well water testing and the evaluation of arsenic and coliform removal by Biosand and ceramic filters. Water test sites' coordinates are recorded with GPS and then mapped with ArcGIS. In coliform tests, RDI tests for total colonies per mL instead of a typical presence/absence test. In order to ensure continued accuracy, RDI checks themselves against other labs by sending out samples for comparison.

1.1 Creating a laboratory

The basic requirements for a lab that would have the capacity to serve most of Ghana's water quality needs include:

1. Incubator
2. Turbidity meter
3. Photometer (YSI, Palintest) and vial
4. Test of chlorine residual
5. Bunsen burner
6. Pressure cooker
7. Miscellaneous glassware including flasks, graduated cylinders, cylinders
8. Reagents
9. pH meter
10. Thermometer
11. Pipettes
12. Disposable syringes
13. Syringe membrane
14. Cleaning paper, brushes, and other cleaning supplies

Dr. Sampson recommends Palintest for all determinants except for arsenic, for which he recommends the use of Hach reagents. For is work in Cambodia, he believes that Yellow Springs Instruments (YSI) provides the best instruments, on a basis of cost and quality.

1.2 Current Findings

RDI is currently working with microbiologists Mark Sobsey and Prof. Joe Brown of the University of North Carolina. Their recently published findings on the ceramic filter indicated that the rates of adoption and continued use were promising. Similarly, preliminary studies of goethite clay for greater electromagnetic virus removal have been promising, but remain incomplete.

2 POU Water Sanitation Products

According to RDI, it strives to produce inexpensive and culturally appropriate systems that can address the problem of providing clean water to households and schools throughout rural and urban Cambodia. Having studied a number of strategies and products, at present they work on ceramic water filters and ultra-violet water purification chambers.

2.1 Biosand Filter

RDI does not recommend Biosand filters because of the variability of their output. Since the filter is biologically dependent, a shift in the composition or pH of the water source (for instance, after a heavy rain) can temporarily decrease the filter's effectiveness. Moreover, in high sediment conditions, the filters underperform due to the frequency of maintenance required, and the several days that are required to reestablish the biofilm after cleaning. RDI's recommendation is to filter no more that 18L per day through a Biosand filter, and to always use post-filter treatment like boiling or solar disinfection.

2.2 The Ultra-Violet Light Filtration System

Using PVC pipes and a UV-bulb, RDI has developed a US$ 20 filter that can act on about 100 gallons of water per hour. So long as the water is not turbid, these systems promise to be a very effective method of purifying water in public dispensation areas as well as urban homes. Unfortunately, turbid water requires pre-treatment solid filtering, and areas without consistent electricity will have to rely on car batteries for power – a costly product that, if subsidized, is not usually put to use for water treatment but instead used on home televisions and light bulbs.

2.3 Ceramic Filter

RDI's fully automated manufacturing site was constructed in 2003. The factory has achieved a number of significant improvements in the production process in their 3 years of operation. The composition of the filters has been adjusted to use locally available materials (rice husks for sawdust) and on-site research has improved the efficacy and lowered the cost of their silver treatment.

In addition to making quantifiably high-quality filters, RDI has made progress on making the rest of the filter parts locally producible and culturally acceptable. They have invested in building the capacity of local plastics manufacturers so that they can source their food-grade, plastic water receptacles down the street. They have contracted with local rattan producers to make attractive stands that keep the filters out of direct sunlight and off the ground. They have also devised a method of attaching an additional 20L of input water for Cambodian families, which are typically larger than 6 people.

3 The Factory

RDI has a unique advantage in its location: less than a mile away from the Royal Brick Factory, they are able to acquire unfired bricks conveniently and cheaply. These bricks are crushed using steel elephant-foot pounders, and then processed in a risk husker. The resulting fine-grained powder is bagged and brought over to the mixing site daily. Instead of using sawdust, they use locally available and inexpensive rice husks. A made-to-order mixer is used to mix clay, water, and rice husks. 8kg of clay mixture is used per filter, a number that has been refined after on-site experimentation to best fit their molds.

Clay is thrown into blocks and then placed in a fully-automated hydraulic press. The resulting pot is then refined by hand and placed to dry for several hours before receiving another round of refinement. They are then stiff enough to move, and are place on drying racks that are coded by day of production to ensure the proper firing date. Tarps are employed to keep the pots dry in case of rain; otherwise they are left in the sun to expedite drying.

At 96 filters per firing, RDI has the largest capacity kilns of any of the factories visited. The square kilns, which have been modified with an arched roof for better stability and heat circulation, are built with three layers of brick, making them thicker than the Potters-for-Peace standard and thus better insulated.

Fired filters are then visually inspected for cracks and placed on a rack of gutters and checked with a special marked PVC tee for flow rate. Acceptable flow rates are between 1.5 and 2.2 liters/hour. The filters that pass quality control are then set aside for silver coating. 300mL of silver nitrate solution are painted by brush onto each filter: 200mL on the inside and 100mL on the outside. The silver solution is made on-site using silver nitrate in powder form.

The filters are then placed inside the plastic containers along with the faucet, a brush, a packet of bleach solution, and educational material. The plastic container is then taped shut. Completed units can be stacked 6-8 units per cubic meter. Periodic water quality tests are performed on completed filters. RDI sees any loss below 10 percent as acceptable. Currently, the factory estimates a 5-8% loss over the course of the manufacturing process.

4 Social Marketing

RDI has developed many innovative materials and methods to train users and potential customers in the theory behind the filter and its use. Before bringing filters to a village, RDI conducts a poverty assessment survey to determine which households will be unable to afford a filter even if they are eager to use one. After meeting with local community leaders to gain approval for their list of households, they will use vans with onboard speakers and televisions to deliver filters and present educational karaoke videos and puppet-based training shows to the community. They use puppets, live-action narratives, flip charts, and brochures to explain a number of issues related to water health and sanitation as well as proper filter use and maintenance.

RDI distributes selectively filters through a carefully vetted group of pharmacists. In order to qualify, pharmacists must have well-respected businesses that offer a high quality of service. Rather than choosing local pharmacies, RDI believes that it is better to target larger pharmacies with a larger customer base; these pharmacies can always sell individually to smaller shops that need them. Pharmacists must be willing emphasize training over selling.

At the time of the visit, the factory was selling about 10 filters per week to walk-in customers. The manufacturing process was close to being fully sustained through local purchases. A large proportion of sales continued to be in large quantities to other NGOs.

The breadth of the project has been kept small purposefully to ensure high quality. Their level of quality is imperative, both from an ethical standpoint, and in the long-term marketing perspective. It seems that there may be unexploited opportunities for keeping quality a focus while marketing more broadly to local and individual buyers, including expanding the accessibility of their training media and developing a trainer-of-trainers program.

Cambodian Red Cross (CRC)

Contact

M. Sichan / Mao Song (Factory Manager)
#17 Street 180
Phnom Penh, Cambodia
Phone (Office): 012-976-805
Phone (Factory): 001-742-719

Summary

The Cambodian Red Cross water filter factory is the newest ceramic silver filter operation in Cambodia. It was begun in early 2005, and build according to advice provided by IDE based on RDI's findings. The pilot project and the factory construction were originally funded by the World Bank's Development Marketplace Competition and by the American Red Cross[1].

CRC filters at a glance:

In raw costs, 1 ceramic pot costs about $4.50. At the factory, the ceramic pot is not available for sale. Below is a table of costs incurred per filter:

Item	***Cost in USD***	***Sale Price***
Water receptacle	$2.50	-
Spigot	$1.00	-
Ceramic Element	$4.50	-
Threaded PVC connector	$0.10	-
Total	**$6.30***	**$7.20**

***** The costs per filter part were not consistently quoted. At the CRC office we were told that costs were $2.50/plastic bucket, $1.00/spigot, and $4.50/ceramic pot, for a total of $8.00. At the factory, the manager seemed unaware of actual costs. The filter can be purchased from the factory for $7.20.

[1] The pilot project was funded through ARC and the factory construction was funded by the ARC and the DMWB.

1 Project History

Before beginning construction on the factory, CRC began by conducting a pilot project in Prey Veng province in 2003. The project targeted 5 districts with 125 villages over a course of one year. The purchased 1000 ceramic water filters from IDE for $12.00 per unit, including shipping. 500 of these were distributed to temples and another 60 went to public health centers. The temple outreach was unsuccessful as monks prefer to boil water for tea. The CRC has had a very difficult transition from free distribution to commercialization. 200 volunteers were recruited and paid $0.50 for every filter they sold. As an added incentive, they were given a free filter for every 10 they sold. CRC staff used a pickup truck (capacity 90 filters) to sell an additional 200-300 filters per week. Volunteers made very few actual sales.

After the pilot project ended, the CRC had enough funds to sustain the project for an additional 6 months. Nonetheless, they chose to expand their scope to include all 24 provinces of Cambodia. During these six months, the CRC marketing plan was centered on an initial visit, where one filter was sold, followed by a return trip some weeks later after “word had spread.” Unfortunately, marketing costs proved to be higher than the income generated through sales. As the funds ended so did their ability to make repeated trips to remote areas. In order to cut down on costs, CRC stopped offering $0.50 per filter and so distributors ceased their operations. The remaining filters were sold by CRC staff at a reduced rate of $5.00 per unit.

2 The Factory

The factory was built with the help of a consultant hired from IDE, although the factory resembles RDI’s operation far more than IDE’s. Land in Prey Vang was purchased for $4,000. Electricity is provided by a generator as it is not available in the area. Water was originally provided by an IDE treadle pump that broke five months after installation. The factory now uses a 60-meter deep well that cost $1,700 and uses a submersible pump.

The factory has a hand press and a combo hydraulic/hand press. A hand-turned wheel brings the clay and pressing plates to close proximity, with an electric-powered 50-tong jack provided the force for the final few inches. After pressing, all pots are wiped down with a hard plastic tool to smooth the pot, much as at RDI. The pots are then moved into a covered warehouse that stores a number of drying racks, which are not coded or monitored in any way to guarantee an appropriate firing date. Depending on weather conditions, pots are dried for 3 or 4 days before firing.

The factory has several kilns flat-roofed square kilns, identical in design to the IDE kilns. They are reinforced with iron, but have no bag-wall or floor to protect the filters from direct heat. Each has a capacity of 60 filters per firing. From the exterior, the insulation looked severely cracked. It is claimed that a firing temperature of 830 degrees Celsius is reached, as verified by a pyrometric cone. Pyrometric cones are not checked on every firing. Filters next to the fire-chamber are darkly red.

Throughput is theoretically 3000 units per month during the dry season and 1500 units per month during the wet season. The factory manager said that they can produce a maximum of 55 units a day, for a total of 1530 filters per month at maximum production. He estimates a 10-15 percent loss.

International Development Enterprises (IDE)

Contact

Michael Roberts / Varidh
#126 St Ta Phon Boeung Tumpun Khan Meanchey
Phone: 855-23-223-541
idemarketing@online.com.kh

Summary

IDE was the first program to produce the ceramic filter in Cambodia. They have spent a tremendous amount on product marketing: nearly US$ 13 per filter produced. According to several visiting engineers, several residents of Phnom Penh showed positive recognition of the Rabbit-brand ceramic filter. Overall, though, their marketing campaign seem to discourage other safe water practices like boiling water (a dangerous precedent to set) and their educational tools are for the most part delivered in lecture format.

IDE filters at a glance:

- Unmeasured pore size
- 8L capacity
- 3L/hour flow rate
- Microdyne colloidal-silver painted
- Food grade, pigment-less plastic container
- Plastic faucet

1 Marketing

IDE has chosen to target pharmacies as retail outlets. Acting through an IDE translator, we learned that one pharmacy they brought us to had sold 10 filters for the month of July. Statistical data provided by the IDE office in Phnom Penh showed a steady increase in local retail sales over the last two years, with a distinct move from selling primarily to the donor community.

IDE's main marketing thrust has been conducted through television commercials and radio programming. This has been an expensive choice, and there is some question as to whether it can adequately reach the rural poor and those without access to radios or televisions. The IDE marketing strategy adds about $13.00 to the cost of a filter. These costs are covered by addition grants, and thus are not recouped in the sale price. IDE's marketing strategy was not developed beyond mass-media outreach and the use of pharmacies as retailers.

2 The Factory

The IDE factory is located in Kampunchinang, a region known traditionally for its skills in pottery making. As the filter-making and firing process differs from traditional pottery techniques, this knowledge base does not seem to have provided the IDE factory with any readily identifiable advantage over the RDI and CRC factories.

We have several concerns over the quality of the product and production process at the IDE factory. The factory is laid out in such a way as to not be conducive to tracking a batch of filters through the construction process. As a result, there are opportunities created for compromises in quality control, especially in the amount of drying time before firing and in the consistent application of colloidal silver. The starting clay has quite a bit of organic matter in it, and though the clay goes through a hammer mill and a sieve, it was not demonstrated that the organic matter was effectively removed. Moreover, workers must transport the clay from wherever they can find it to their workplace by hand each day, making consistency of clay composition nearly unattainable. This clay is placed directly on the ground and uncovered during rain, prolonging the time it takes for the clay to become sufficiently dry to be ground.

The factory uses a large hand-screwed press that requires two people to operate. After the filters are pressed, the factory does not have sufficient covered area to dry the filters before firing. The IDE kilns are in various states of disrepair, and can hold 50-60 filters per firing. The square kilns are flat-roofed with iron doors. They are not equipped with a bag wall to protect the filters from the direct heat of the flame, nor is there a floor between the fire chamber and the filters.

Also of significant concern is the practice of producing filters with flow rates of 3 liters per hour. Although IDE claims that the filter is still effective at these rates, they do not have any evidence to support this claim. The laboratory tests that IDE has conducted on a 3L/hour filter were not continued past the period in which silver is the primary antimicrobial agent. It is unclear whether colloidal silver is consistently applied, as a factory worker had to spend several minutes searching in the back of the warehouse for a jar (unopened) of colloidal silver.

Appendix I: RDIC

Production method:

See attached.

Appendix II: CRC

Production method:

Clay

1. Purchase unfired bricks from brick factory at cost of 50 Riel/brick with transportation
2. By hand and using a small stick, bricks are crushed into small pieces and then pounded against a hardened brick
3. Crushed clay is placed into a hammer mill for further processing

Rice Husks

4. Rice husks are sieved and then shipped to the factory

Mixing

5. Rice husks, milled clay, and water are put into a mixer identical to that at RDI (without the automatic water-injection) at a ratio of 33 parts clay : 8 parts rice husks : 11 parts water (they mix enough to produce 5 filters at a time)
    a. Rice husks and milled clay are mixed for an un-regulated amount of time
    b. The mixer is stopped and water is added
    c. Officially, mixing is then continued for 15 minutes; on the day of the visit, a sample batch spent 6 minutes in the mixer
    d. 10kg of wet clay-husk is measured and rolled into a ball

Pressing

6. The batches are pressed using one of two presses: a hand-press identical in design to the IDE press, and a modified hand/hydraulic press

Drying

7. Filters are dried on a rack for 3 days during the dry season and 4 days during wet season

Firing

8. Filters are fired for 12 hours 30 minutes at 830^{o}C and then left in place to cool for one day
    a. Firing is begun at 3am and finished at 5pm
    b. Each kiln holds 60 pots
    c. A pyrometric cone is used to determine when 830^{o}C is reached, although it appears that temperature is not checked with every firing
    d. Each firing uses 3 cubic meters of large-board wood
    e. Charcoal from firing is not reused

Testing

9. After firing, filters are soaked in a pool of water for 12 hours, after which the flow rate is checked. Anything within 2-3L/hour is deemed acceptable

Silver Application

10. Colloidal silver solution is applied at 300mL per filter
    a. IDE supplies the colloidal silver
    b. 1L of colloidal silver can be used on 1000 pots

Appendix III: IDE

Production method:

Clay

1. Purchase raw clay (the factory uses 8 cubic meters/week at a cost of US$ 4/cubic meter)
2. Clay is crumbed into small pieces by hand and then crushed by hand against a hardened brick
3. Crushed clay is put into a hammer mill for further grinding
4. Clay from the hammer mill is sieved, although at this stage most organic matter has been made particulate by the hammer mill

Rice Husks

5. Rice husks are put through a 0.75 mm sieve and then shipped to the factory at a total cost of 370 Riel per 1 kg

Mixing

6. Rice husks, milled clay, and water are put into the mixer (8 kg rice husks, 26 kg milled clay, and 10 L water)
    a. After dry mixing for 8 minutes, 1/3 water is added
    b. At the 10 minute mark, the remaining 2/3 water is added
    c. Mixing continues for 5 minutes
    d. 9 kg mixed clay is measured and rolled into a ball for one filter

Pressing

7. Clay ball is pressed by two people on a hand-operated screw press

Drying

8. Although there seem to be insufficient drying racks, the factory claims filters spend 7 days on the drying rack during the dry season and 14 days during the rainy season

Firing

9. Filters are fired for 12 hours in a kiln at 830 degrees Celsius, then allowed to cool for 1 day
    a. Each kiln holds 50 pots
    b. A pyrometric cone is used to determine when 830 degrees Celsius is reached
    c. The viewing hole is closed 5 hours after lighting

Testing

10. Fired filters are soaked for 6-12 hours in a pool full of unfiltered water, at which point the flow rate is checked by setting a filter full of water inside a plastic bowl. Anything within 2-3 L/hour is considered an acceptable flow rate

Silver Application

11. 300 mL of colloidal silver solution is applied to each filter
    a. Microdyne in Mexico supplies the colloidal silver at US $1500 for a 200 L barrel. When shipping to Cambodia is included, the price is $2100 per barrel
    b. 1 cc of colloidal silver is measured by syringe and mixed with 300 cc of water; 1 L of colloidal silver can coat 1000 pots