Analysis and Sourcing of the Mechanical Equipment Required for a Ceramic Pot Filter Production Facility

by

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ABSTRACT

Research was done into identifying and sourcing the mechanical equipment required for manufacturing ceramic pot filters, specifically for use in the Pure Home Water factory in Northern Ghana. The pieces of equipment identified were a hammer mill, a mixer, a pug mill, and a mechanical press with molds for pressing the filters. Evaluative criteria for each machine were developed, and machines available from manufacturers and machines produced locally were evaluated based on these criteria.

Several machines fit the evaluative criteria and were recommended for the Pure Home Water facility. The Meadows Model 5 hammer mill was recommended for purchase from the manufacturer. Of the mixers researched, the mixer made by RDI-C, the Bluebird 24S mixer, and the mixer designed by Prof. Manny Hernandez all satisfy the requirements of Pure Home Water. The pug mill recommended for Pure Home Water was the Venco 75mm pug mill. The Mani Press and the paraboloid molds were also recommended for the Pure Home Water facility.

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I would like to thank all the manufacturers who provided information on their products for this thesis. I would also like to thank all those involved in producing ceramic pot filters around the world, all those who have dedicated themselves to bringing safe water to every person who needs it. Their commitment, perseverance, and creativity have inspired me in the short time that I have been involved in their work.
Contents

1 Introduction ....................................................................................................................6
  1.1 Unsafe Water .................................................................................................... 6
  1.2 Ceramic Pot Water Filter ........................................................................... 6
  1.3 Production Process Overview ........................................................................ 7
  1.4 Pure Home Water ............................................................................................15

2 Thesis Statement and Research Methods ............................................................... 16
  2.1 Thesis Statement ...............................................................................................16
  2.2 Research Methods ............................................................................................16

3 Mechanical Equipment for a Ceramic Pot Filter Factory ...................................... 17
  3.1 Pure Home Water - Ghana Factory Specifications ............................................17
    3.1.1 Capacity ..............................................................................................................17
    3.1.2 Power ....................................................................................................................18
  3.2 Hammer Mill ......................................................................................................18
    3.2.1 Introduction .............................................................................................................18
    3.2.2 Motor ......................................................................................................................19
    3.2.3 Hammers ...............................................................................................................19
    3.2.4 Safety ....................................................................................................................19
    3.2.5 Maintenance of Hammer Mill Screen ............................................................... 20
    3.2.6 Hammer Mill Options (Commercial Products) .................................................20
  3.3 Mixer ...................................................................................................................23
    3.3.1 Introduction .........................................................................................................23
    3.3.2 Drum Mixer .........................................................................................................23
    3.3.3 Clay/Mortar Mixer ..............................................................................................25
    3.3.4 Mixer Options .....................................................................................................26

3.4 Pug Mill ................................................................................................................29
  3.4.1 Introduction .......................................................................................................29
  3.4.2 Maintenance .......................................................................................................32
  3.4.3 Safety ...................................................................................................................32
  3.4.4 De-airing ............................................................................................................33
  3.4.5 Combination Mixer/Pug Mill .............................................................................34
  3.4.6 Pug Mill Options ...............................................................................................35
1 Introduction

1.1 Unsafe Water

According to the WHO, nearly one billion people are forced to rely on unimproved water sources for their drinking needs (UNICEF; WHO 2009). Consumption of unsafe drinking water results in the spread of waterborne disease; one of the most common, and dangerous, conditions caused by pathogens in unsafe water is diarrhea; almost 88 percent of all deaths caused by diarrhea are connected to unsafe drinking water (UNICEF; WHO 2009). Diarrhea is the second most common cause of death in children under 5, killing 1.5 million each year; 80 percent of these deaths occur in Africa and South Asia, in some of the poorest nations in the world (UNICEF; WHO 2009). Not only do the people not have access to safe water, but they are forced to live in extreme poverty and cannot afford most high-tech solutions to water treatment.

1.2 Ceramic Pot Water Filter

The ceramic pot water filter is a low-tech, inexpensive, and effective solution to provide safe drinking water for the one-sixth of humanity that only has access to unimproved water sources. The filter also serves as a solution for those with improved water who seek an extra barrier of protection to ensure safe drinking water. The design was developed by Dr. Fernando Mazariegos in 1981; as can be seen in Figure 1, the filter itself is simply a pot-shaped device made of pressed, fired clay, mixed with a combustible and coated with colloidal silver.
The filter works by allowing water to seep through the pores, physically straining pathogens and fine particles of dirt out of the water. Pores in the filter are made by mixing in organic “burn-out” material such as sawdust, rice husk, or other combustible material. When the pressed filter is fired at 870 degrees Celsius, the burn-out material incinerates, leaving pores through which water can pass. The filter is also coated with a colloidal silver solution that acts as a bactericide, killing pathogens in the water.

The advantage of the ceramic pot filter over other solutions is that most of the raw materials needed for construction, including the clay, the water, and the burn-out material, are readily available in the developing countries that suffer from a lack of access to an improved water source. A filter production facility can be established in the area, and once the proper equipment is obtained or fabricated on-site the facility can operate mostly, or entirely, on supplies and materials available locally.

1.3 Production Process Overview

There are 35 operational ceramic pot filter factories in the world, and each factory adheres to the same basic procedures for producing the filters (Rayner 2009).

First, the clay and the burn-out material must be processed. This can be done either manually by crushing and sifting the clay and burn-out material using a mortar and pestle or by milling the clay and burn-out material in a hammer mill.
Figure 2: Women manually pulverising clay (Murcott 2010)

Figure 3: Man operating a hammer mill (Leah Nation, 2010)
The processed materials are then measured and combined. First the clay, the burn-out material (and the grog if used) are first mixed together dry. Grog is clay that has been previously fired and ground up. Once an even dry mixture is made, water is added; they are combined either by hand or in a mixer which may be powered manually, or by a motor running off of fossil fuels or electricity. Whichever method is used, the materials are mixed until a homogeneous mixture of the material is achieved.

Figure 4: Women mixing by hand (Leah Nation, 2010)

Figure 5: An engine-powered clay mixer (Resource Development International - Cambodia 2008)

After the clay, combustible, water, and grog are combined into a wet mixture it must be processed further to ensure that the mixture is homogeneous and to eliminate any large
air pockets in the clay, improving its strength and workability. This can be achieved by wedging the clay by hand, or by processing the clay in a pug mill. Since a filter factory processes a large volume of clay and combustible each day, manually wedging the clay can be a physically demanding job and a strain on workers.

![Figure 6: Woman wedging clay by hand (Steve Buchele, 2010)](image)

The fully processed clay is then cut into properly-sized blocks that correspond to the mold and filter size, between 7.5 and 8.5 kg per block. Each block is then placed into a mold in a hydraulic filter press, which can be powered either by a hand-operated hydraulic jack or
by a hydraulic system powered by an electric motor. After the press has been used the freshly-pressed filter is set out on racks to be air-dried.

Figure 8: Standard pot-shaped filter press (Susan Murcott 2010)

Figure 9: Paraboloid filter press; pressed filters visible in the foreground (Steve Buchele, 2010)
The pressed filters must be air-dried before firing to prevent rapid shrinkage and cracking of the clay. Once the filters are dry enough they are loaded in a kiln to be fired. The kiln must be closely monitored using pyrometric cones and/or a pyrometer to gauge the internal temperature.

Figure 10: Filters being air-dried on racks (Resource Development International - Cambodia 2008)
After being fired the filters must be cooled. Once cooled the filters are immersed in water and soaked until they reach full saturation. The saturated filters can then be put through a flow rate test to ensure that the flow rate is not too high or too low; the typical flow rate desired is between 1L and 2.5L per hour.
Filters that pass the flow rate test are either painted or dipped with colloidal silver or silver nitrate, both of which act as a bactericide. The filters are then ready for packaging and distribution. The final filter must be placed in a receptacle that will hold the filtered water; in Figure 14 the filter is inside a plastic receptacle with a tap at the bottom.
1.4 Pure Home Water

Based in Tamale, the regional capital of Northern Ghana, Pure Home Water is a non-profit organization founded by Susan Murcott, Senior Lecturer at MIT, with local partners. Approximately 1.8 million people in the Northern Sector of Ghana currently rely on unimproved water sources for their water supply, exposing many to water-borne disease. Pure Home Water seeks to provide local, low-income households in Northern Ghana with access to safe drinking water through use of ceramic pot filters, locally branded as “Kosim” filters. Since its establishment in 2005, Pure Home Water, relying on filters produced in the capital Accra, has already supplied over 100,000 people with the Kosim filter. A filter production factory is currently under construction; when finished, it will enable Pure Home Water to produce filters on-site and at a greater rate.
2 Thesis Statement and Research Methods

2.1 Thesis Statement

The goal of this thesis is to identify and source specific pieces of equipment for use in the ceramic pot filter manufacturing process. The focus will be on identifying a hammer mill, a pug mill, a mixer, and a mechanical press that satisfy the requirements for the manufacturing process. The evaluative criteria will be based on the needs of the current filter production facility under construction in Tamale, Ghana, taking into consideration the mechanical requirements, the energy availability, and the cost of purchasing the mechanical equipment or the ability to fabricate the mechanical equipment locally. It will also consider worker safety and environmental impacts. Both manual options and those that require an energy source will be considered. Design drawings and detailed specifications will be provided, along with information on potential supplies. While the focus will be on the conditions and requirements of the factory in Ghana, general requirements that are not dependent on location will be looked at to identify and source equipment that can be used at any ceramic filter production facility around the world. Recommendations based on the evaluation criteria will be provided.

2.2 Research Methods

The primary mode of research for this thesis was the review of documents provided by groups and organizations involved in the production of ceramic pot water filters. While
there are some documents that detail the ceramic pot filter manufacturing process, few go into details on the mechanical equipment used during the process. The primary pieces of mechanical equipment that concern this thesis are the hammer mill, the mixer, the pug mill, the mold, and the filter press. Information on the specifications and details of the machinery mentioned in this thesis was obtained directly from manufacturers or resellers of the machinery and from designers of machines that have been fabricated on-site at various filter factories around the world. Supplemental information on ceramics and the properties of clay were obtained through personal communications with ceramicists and from published literature on the subject.

3  Mechanical Equipment for a Ceramic Pot Filter Factory

3.1  Pure Home Water - Ghana Factory Specifications

3.1.1 Capacity

The target production capacity of the facility is 50 filters per day in the short run, and 100 filters per day once a second large kiln is constructed. The long run target of 100 filters per day will be used to determine the desired capacity of the machinery.

The dry mix for each filter at the Pure Home Water factory consists of 5.5 kg of dry clay powder, 1.0 kg of dry fine rice husk, 1.0 kg of dry waste rice husk, and an optional 0.5 kg of grog (Miller and Watters 2010). At the upper limit the hammer mill will need to output 8.0 kg of the dry components per filter; at 100 filters per day, the hammer mill must output 800 kg per day. Assuming a workday of 8 hours the hammer mill must process at least 100 kg/hour.

The 7.5-8.0 kg of dry mix is combined with about 0.5 L of water, producing 8.0-8.5 kg of wet mix per filter. At the upper limit the mixer will need to output 8.5 kg per filter, or 850 kg per day. The pug mill will also have to achieve this level of output, 850 kg per day. Therefore both the pug mill and the mixer, operating constantly during a workday of 8 hours, must be able to process at least 106.25 kg/hour.

Table 1: Necessary Capacity of Hammer Mill, Pug Mill, Mixer, at 100 Filters/Day

<table>
<thead>
<tr>
<th>Machine</th>
<th>Hammer Mill</th>
<th>Mixer</th>
<th>Pug Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Capacity (kg/hour)</td>
<td>100</td>
<td>106.25</td>
<td>106.25</td>
</tr>
</tbody>
</table>
3.1.2 Power

The Pure Home Water factory in Ghana currently has 2 generators available to power the factory equipment. The larger generator runs on gasoline and supplies single-phase, 230V power at 50Hz and is rated for an output of 5kW. The other generator runs on diesel and provides single-phase, 220V power at 50Hz and is rated for a continuous output of 2kW. Therefore any equipment purchased that requires electrical power must run off of single phase, 220-230V power at 50Hz without exceeding the maximum possible output of the larger generator at 5kW.

3.2 Hammer Mill

3.2.1 Introduction

The primary use of the hammer mill in the filter making process is to take the dry materials, which include the clay, the combustible material, and the grog, and to reduce them to the correct particle size in preparation for the mixing process.

A typical hammer mill takes in material through a hopper which feeds into a circular milling chamber. In the milling chamber the material is pulverized by rotating hammers. The hammers are attached to a central shaft driven by a motor. A screen in the bottom of the milling chamber allows particles that are sufficiently small to pass through.

![Figure 16: Schematic showing key components of a hammer mill](image)  

According to the Ceramics Manufacturing Working Group’s Best Practice Recommendations for Local Manufacturing of Ceramic Pot Filters for Household Water Treatment, 23 out of the 25 surveyed filter factories use hammer mills (The Ceramics
Manufacturing Working Group, 2010). The document recommends that a flail-type mill be used instead of one with fixed blades to prevent damage if non-millable material is accidentally processed (The Ceramics Manufacturing Working Group, 2010). According to Potters For Peace, a small hammer mill with interchangeable sieves powered by a 2-3hp motor should be used (Potters for Peace 2010). However, higher powered hammer mills can be used; for example, the Resource Development International – Cambodia (RDI-C) uses a hammer mill powered by a 3.7kW (5hp) motor (Resource Development International - Cambodia 2008). The FilterPure factories in the Dominican Republic and Haiti both use a 220V single phase 5hp motor, as does the Imabridge facility in Nigeria; all three are powered by generators (Hernandez, 2010).

3.2.2 Motor

Higher powered motors are able to provide more torque or speed. Higher torque allows the mill to deal with larger and harder particles. Increased rotational speed allows more frequent contact between the hammers and the particles and results in higher output rates.

3.2.3 Hammers

There are two specifications related to the hammers in a hammer mill: the number of hammers and the length of the hammers. If the rotational speed remains constant, an increase in the number of hammers results in more frequent impacts between the hammers and the particles, which in turn results in a higher output rate. An increase in the number of hammers requires a corresponding increase in the width of the milling chamber to accommodate the hammers.

If the length of the hammers is increased while maintaining the rotational speed, the tip speed of the hammers will also increase. Since much of the contact between the hammers and the particles occurs at the hammer tip, increased tip speeds result in higher magnitude impacts and a more effective pulverizing process. The length of the hammers is directly related to the diameter of the milling chamber; if longer hammers are desired, a larger mill is required.

Both increasing the number of hammers and increasing the length of the hammers force a greater load on the motor. If rotational speed remains constant, the increased mass of the system will require more power to drive it, so a motor with higher torque is required.

3.2.4 Safety

The dust produced during the operation of a hammer mill can pose a serious health risk to people nearby. Inhalation of fine dust and silica can cause silicosis, a respiratory disease characterized by coughing, shortness of breath, and fibrosis in the respiratory
system. To limit the amount of dust workers are exposed to, a sack or other receptacle to collect the milled material must be well secured to the outlet of the hammer mill. The hammer mill should be operated in an area with adequate ventilation, and workers must wear face masks and goggles.

3.2.5 Maintenance of Hammer Mill Screen

One of the most common failure points of a hammer mill is the screen. A damaged screen severely affects the quality of the milling process by letting through particles that are too large. Any such particles must be re-milled. Holes in the screens may be patched or closed off, allowing the screen to function properly, but at a reduced output rate. Since the screens are precisely machined, broken screens will have to be replaced.

3.2.6 Hammer Mill Options (Commercial Products)

<table>
<thead>
<tr>
<th>Model</th>
<th>Power (kW)</th>
<th>Capacity (kg/hr)</th>
<th>Size</th>
<th>Weight</th>
<th>Cost ($US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meadows Model 5</td>
<td>3.7-11.2</td>
<td>181-544</td>
<td>N/A</td>
<td>227kg</td>
<td>1680</td>
</tr>
<tr>
<td>Schutte-Buffalo</td>
<td>1.5</td>
<td>25-100</td>
<td>0.8m x 0.43m x 0.43m</td>
<td>125kg</td>
<td>6750</td>
</tr>
<tr>
<td>WA-6-H</td>
<td>7.5</td>
<td>50-250</td>
<td>1.5m x 0.6m x 0.8m</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
3.2.6.1   Meadows Model 5

Figure 17: Meadows Model 5 Hammer Mill

The Meadows Model 5 hammer mill has a variety of power options. It can be configured to run off of a 5-15 hp motor which can be purchased from the manufacturer; it can also be belt-driven or direct driven with a gasoline/diesel engine. The operating RPM of the mill depends on the method used to drive the mill. The Meadows Model 5 is manufactured by Meadows Mills Inc. (http://www.meadowsmills.com/index.htm).
The Schutte-Buffalo WA-6-H and WA-8-H are two of the models of the Schutte-Buffalo E-Cycler line. They are driven by totally enclosed, fan-cooled electric motors built into the system, operating at 3-phase, 60Hz, 230-460V, 1800rpm. The rotor assembly includes swinging hammers that are 4-way reversible. The Schutte-Buffalo E-Cycler is manufactured by Schutte-Buffalo Hammermill (http://www.hammermills.com/).
3.3 Mixer

3.3.1 Introduction

The Ceramics Manufacturing Working Group reports that 16 out of 25 filter factories surveyed use powered mixers (The Ceramics Manufacturing Working Group 2010). The group suggests mortar-style mixers that are horizontally oriented with blades rotating between 40-50rpm; the group states that hand-operated mixers with rotating drums are not recommended (The Ceramics Manufacturing Working Group 2010). The RDI-C group uses an automated system to supply an even distribution of water to the clay mixture in the mixer (Resource Development International - Cambodia 2008).

The mixing process is integral to filter production; proper mixing results in a homogeneous distribution of the burn-out material in the clay. There are various types of mixers, but the general mixing process is always the same. First the dry components, which consist of the clay powder, the combustible, typically sawdust or rice husk, and the grog if desired, are added to the mixer after they have been sieved to the correct particle size. These materials are mixed until the clay and burn-out material are evenly distributed throughout the dry mix. Once the mixture reaches an adequate consistency the water is added to the mixer. The mixing process then continues until a homogeneous mixture is obtained.

There are two basic styles of mixers that can be used: the drum mixer and the clay/mortar mixer.

3.3.2 Drum Mixer

A drum mixer consists of an empty chamber, or drum, that can be filled with material to be mixed. Once filled the drum is rotated to mix the material. The drum mixer should only be used to mix the dry materials, and should not be used in wet mixing with water. The mixer also minimizes the production of dust since it is an enclosed chamber during the dry mixing process.
As shown in Figure 19, some drum mixers can be hand operated, eliminating the need for a source of electricity; Figure 20 shows a pedal-powered drum mixer in Myanmar. While this does require manual effort and strain, it is a better alternative to simple hand mixing because it results in a much more homogeneous mixture; there is also the possibility of using local farm animals to power drum mixers through a treadmill.
3.3.3 Clay/Mortar Mixer

A clay or mortar mixer consists of a mixing chamber and rotating blades that crush and mix the components. Unlike the drum mixer, the mixing chamber of a clay/mortar mixer remains stationary. The blades are attached to a rotating shaft which is usually driven by a motor. Unlike the drum mixer, the clay/mortar mixer can handle wet and dry material together.

![Figure 21: Mixing chamber of a mortar mixer; the blades are visible, attached to a rotating shaft](image)

In a drum mixer, much of the work is done by gravity as the mixture rises and falls in the rotating drum. However, in a clay/mortar mixer, most of the work is done by the rotating blades as they impact the components of the mixture. Therefore, clay/mortar mixers usually have motors that run at higher speeds and demand more power than motors found in drum/cement mixers.

Clay mixers are designed to work with material with the consistency of wet clay, and can be used without modifications. However, most mortar mixers are designed to mix cement rather than clay, and because cement mixtures are more liquid than clay mixtures the mortar mixers run at speeds that are too high for clay mixtures. As described by Potters for Peace, any clay mixer must run at 40-50 rpm; if the mixer runs faster than that, it must be modified to run at the required speed (Potters for Peace 2010). A gear reduction box or a pulley system can be used to reduce the speed of rotation. An appropriate technology gear reduction box was made for the Haitian clay mixer by modifying a car differential (Hernandez, 2010).
3.3.4 Mixer Options

Table 3: Specifications of Commercial Mixer Options

<table>
<thead>
<tr>
<th>Model</th>
<th>Motor Power (kW)</th>
<th>Capacity (kg)</th>
<th>Size</th>
<th>Weight</th>
<th>Cost ($US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluebird 24S</td>
<td>1.1</td>
<td>68</td>
<td>1.12m x 0.76m x 1.07m</td>
<td>205kg</td>
<td>4470</td>
</tr>
<tr>
<td>Soldner Studio</td>
<td>1.1</td>
<td>68</td>
<td>0.79m x 0.79m x 1.02m</td>
<td>250kg</td>
<td>4082</td>
</tr>
<tr>
<td>Soldner Professional</td>
<td>3.73</td>
<td>136</td>
<td>1.09m x 1.12m x 1.27m</td>
<td>386kg</td>
<td>5590</td>
</tr>
</tbody>
</table>

3.3.4.1 Bluebird 24S

The Bluebird 24S is a horizontally-oriented clay mixer. The mixer is constructed of stainless steel and can accommodate porcelain clays. The mixing chamber tilts to allow easy access to and removal of the clay, avoiding a situation where the user is forced to bend over and dig out the clay by hand. The Bluebird 24S is made by Bluebird Manufacturing Inc. (http://www.bluebird-mfg.com/).
3.3.4.2 Soldner Studio and Professional

![Figure 23: The Soldner Studio and Professional mixers](image)

The Soldner mixers are vertically-oriented mixers. They consist of steel-reinforced concrete tubs that rotate, forcing the clay into stationary cutting bars inside the mixer. The concrete tubs are heavy, and to empty the mixer users must dig out the clay mix manually. The Soldner mixers are produced by Muddy Elbow Manufacturing (http://www.soldnerequipment.com/).
RDI-C has designed and developed its own clay mixer modeled after a traditional cement mixer. They have also designed and built an automated water supply system to evenly add water to the mixer after the dry-mixing period has ended. A schematic for the mixer can be found in Appendix A.
3.3.4.4 Clay Mixer Fabricated by Prof. Manny Hernandez

Prof. Manny Hernandez has also designed and constructed a clay mixer using locally available materials. The mixer is powered by a single phase, 220V, 7.5hp motor. The mixer pictured in Figure 25 includes a gear reduction box made by modifying a car differential.

Figure 25: Mixer in Haiti built by Prof. Hernandez

3.4 Pug Mill

3.4.1 Introduction

Potters for Peace describes pug mills as optional additions to the filter production process to “better standardize the damp mix,” (Potters for Peace, 2010). The Ceramics Manufacturing Working Group recommends that filter factories obtain and use pug mills if possible because of the improved strength and plasticity of the clay produced; the group also reports that a filter factory in Myanmar has reportedly produced stronger filters as a result of using a pug mill (The Ceramics Manufacturing Working Group, 2010).

A pug mill is a machine designed to take a wet clay mix, grind it, and produce a homogenized clay material. The pug mill replaces the need for manual wedging of the clay, a process that can take several hours and cause severe strain to the wrists, arms, and back. Currently, at the Pure Home Water factory in Ghana, clay is manually wedged by hand, as shown in Figure 26. The EcoFiltro factory in Guatemala uses a pug mill as shown in Figure 27.
Figure 26: Wedging clay by hand (Steve Buchele, 2010)

Figure 27: Pug mill processing clay at a Guatemala EcoFiltro factory (Susan Murcott, 2010)
Most pug mills use rotating, screw-like blades called augers to push the clay along a narrow tubular extrusion chamber and out through a nozzle typically on the order of 3-5 inches in diameter. As the clay is extruded it is manually cut into workable pieces.
3.4.2 Maintenance

Proper, timely maintenance is critical to ensure the long-term capabilities of any piece of equipment, and a pug mill is no different. Workers will have to be trained not only on proper use of the pug mill but also on the maintenance procedures associated with it.

Most pug mills require a supply of lubricating grease to ensure that the auger seals are maintained; for example, the Venco 75mm pug mill requires greasing after 50 hours of operation (Venco, 6). Given that the pug mill will be running at 6-8 hours a day, the seals will require re-greasing almost every other week. A pug mill with simple external access to an inlet for lubricating oil is essential to ensure that the workers can be easily trained to add oil when necessary.

Pug mills are not designed to process dry material, and any material inside the mill at the end of the day must be cleaned out. If dry material does get stuck in the mill, preventing proper operation, the mill may have to be disassembled and cleaned. At least one worker should be trained in the proper disassembly and reassembly of the pug mill. A set of the tools required for disassembly must be purchased separately if not provided by the manufacturer for this purpose.

![Disassembly diagram of a Shimpo brand Pug Mill](image)

Figure 30: Disassembly diagram of a Shimpo brand Pug Mill

3.4.3 Safety

Worker safety must be a top priority, and most modern pug mills have features and mechanisms designed to safeguard the user from injury. No pug mill should be considered that allows open access to the auger blades while the machine is running. The clay hopper
should have a safety seal covering it during operation that prevents the user from coming into contact with the auger blades; such a seal can be seen in the Venco 75mm mill in Figure 31.

3.4.4 De-airing

Some pug mills are classified as “de-airing,” and use attached vacuum pumps to remove the air from the clay as it is processed. While the de-airing process does not improve the plasticity of the clay, it does increase the strength, and also workability, of the clay (Hamer and Hamer 2004). The factories in Myanmar report stronger filters after using clay processed through non de-airing pug mills as compared to clay processed by hand (The Ceramics Manufacturing Working Group 2010). While using clay processed through a de-airing pug mill may produce even stronger filters, it is unknown if the clay will exhibit any decreased porosity that might adversely affect the flow rate of the filters. Taking into account the added maintenance of the vacuum pump and the extra initial cost, de-airing should not be seen as a necessary feature, but its effect on the quality of filters produced should be researched.
3.4.5 Combination Mixer/Pug Mill

The combination mixer/pug mill is a single machine that performs both the wet mixing and the pugging processes. The primary advantage of a combination machine is that it eliminates the need to transport clay from the mixer to the pug mill. With a typical clay mixer, the user is forced to either dump the contents of the mixer into a container or dig/scoop the clay out of the mixer into a container. Either process results in the user carrying the container of clay to the pug mill; since the average batch size for the filters is over 60 kg, the manual labor required can cause serious strain on the body of the user. With a combination machine, however, the user simply adds the separate ingredients and water to the mixing chamber, starts the machine, and after the desired clay mixture consistency is reached, switches the machine from mixing to pugging. The machine then pushes the clay out of the mixing chamber and into the pug milling part of the machine. The user simply waits at the end of the pug mill to cut the clay to the desired working size as it is extruded. The entire process occurs with minimal user input compared to using separate machines, and the self-feeding property of the combo machine eliminates the manual labor required to transport the clay from the mixer to the pug mill. However, workers will still have to carry materials to and from the machine.

![Diagram of the Peter Pugger, a Combination Mixer/Pug Mill](image)

As well as the advantages described above there are also disadvantages associated with combination machines. Combination machines generally are not able to process material as fast as separate mixers and pug mills can. The mixing chamber is also much harder to clean out than a stand-alone mixer.
<table>
<thead>
<tr>
<th>Model</th>
<th>Venco Mk 2 75mm, Deairing</th>
<th>Venco Mk 2, 75mm, Standard</th>
<th>Bailey Model A-400 (Stainless)</th>
<th>Bailey Model A-400 (Aluminum)</th>
<th>Shimpo NRA-04S</th>
<th>Shimpo NRA-04</th>
<th>Bluebird Model 440</th>
<th>Bluebird Model 425</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price ($US)</td>
<td>3605</td>
<td>2200</td>
<td>4000</td>
<td>2998</td>
<td>3500</td>
<td>2900</td>
<td>2749</td>
<td>2319</td>
</tr>
<tr>
<td>Output (kg/hr)</td>
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<td>180</td>
<td>180</td>
<td>180</td>
<td>281</td>
<td>281</td>
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<td>159</td>
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<tr>
<td>Nozzle Diameter (mm)</td>
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<td>75</td>
<td>69.85</td>
<td>69.85</td>
<td>88.9</td>
<td>88.9</td>
<td>76.2</td>
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<tr>
<td>Hopper Opening Size (mm²)</td>
<td>115mm x 110mm</td>
<td>115mm x 100mm</td>
<td>114mm x 114mm</td>
<td>114mm x 114mm</td>
<td>88.9mm x 88.9mm</td>
<td>88.9mm x 88.9mm</td>
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<tr>
<td>Motor (W)</td>
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<td>370</td>
<td>373</td>
<td>373</td>
<td>200</td>
<td>200</td>
<td>249</td>
<td>249</td>
</tr>
<tr>
<td>Vacuum Pump (W)</td>
<td>300</td>
<td>-</td>
<td>373</td>
<td>373</td>
<td>-</td>
<td>-</td>
<td>62</td>
<td>-</td>
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<td>Power Ratings</td>
<td>220-240V, 10A</td>
<td>220-240V, 10A</td>
<td>110V, 10A</td>
<td>110V, 10A</td>
<td>115V</td>
<td>115V</td>
<td>115V, 115V, 5.3A</td>
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<tr>
<td>Weight</td>
<td>80kg</td>
<td>54kg</td>
<td>112kg</td>
<td>95 kg</td>
<td>105kg</td>
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<td>39kg</td>
</tr>
<tr>
<td>Size</td>
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<td>1.08m x 0.34m x 0.37m,</td>
<td>0.65m x 0.3m x 0.57m,</td>
<td>0.65m x 0.3m x 0.57m,</td>
<td>1.02m x 0.22m</td>
<td>1.02m x 0.22m</td>
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<td>Described in Section</td>
<td>3.4.6.1</td>
<td>3.4.6.1</td>
<td>3.4.6.2</td>
<td>3.4.6.2</td>
<td>3.4.6.3</td>
<td>3.4.6.3</td>
<td>3.4.6.4</td>
<td>3.4.6.4</td>
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</table>
The Venco Mk 2 75mm is available in two forms, the standard model and the de-airing model. Both are comprised of an aluminum barrel that houses a single stainless steel auger. The auger is driven by a motor through a high-capacity industrial gearbox. Both models run on electricity and must be plugged into an electrical supply that can provide 220-240V, 50-60Hz, single phase power at 10A. The standard model can be upgraded to a de-airing pug mill by purchasing and applying a Venco de-air upgrading kit. The manual for the Venco 75mm can be found in Appendix B. The Venco pug mills are manufactured by VENCO (http://vencousa.com/).
The Bailey A-400 comes with either aluminum or stainless steel barrels; the stainless steel barrel is designed for porcelain clay, as aluminum reacts with porcelain. The Bailey pug mills are manufactured by the Bailey Pottery Equipment Corporation (http://www.baileypottery.com/index.htm).
3.4.6.3 Shimpo NRA-04 and NRA-04S

Like the two versions of the Bailey A-400, the Shimpo NRA-04 and the NRA-04S are essentially the same machine, with the NRA-04 consisting of an aluminum barrel and the NRA-04S consisting of a stainless steel barrel for use with porcelain clay. The Shimpo NRA-04 models are higher capacity than the other pug mills listed, using the dual augers to provide an output of 281kg/hr (620lb/hr). The manual for the Shimpo NRA-04 and NRA-04s can be found in Appendix B. The Shimpo pug mills are manufactured by Shimpo Ceramics (http://www.shimpoceramics.com).

3.4.6.4 Bluebird Model 425 and Model 440

Figure 36: The Bluebird Model 425
The Bluebird Models 425 and 440 are essentially the same machine; the 440 includes a vacuum pump for de-airing. These two models are defined as “studio pugmills,” rated at a lower output and designed to process 4 tons of clay per year. The manual for the Bluebird Model 425 and 440 can be found in Appendix B. The Bluebird pug mills are made by Bluebird Manufacturing Inc. (http://www.bluebird-mfg.com/).

3.5 Molds

3.5.1 Introduction

There are three different types of molds that are differentiated by the shape of the filter they produce: the flowerpot molds, the paraboloid molds, and the half-spherical molds. The flowerpot molds and filter are the most common design and is currently supported by Potters for Peace, while the paraboloid molds and filter are relatively new, designed by Prof. Manny Hernandez, and is currently supported by FilterPure and Pure Home Water. The half-spherical molds and filter were designed by Curt Bradner for use in Myanmar and Thailand.

Both the paraboloid and the half-spherical filters feature rounded bottoms which may provide improved strength and structural integrity (The Ceramics Manufacturing Working Group 2010). The paraboloid filter has been found to have a lower flow rate than the flowerpot filter, but not to such an extent as to render it inferior to the flowerpot filter (T. R. Miller 2010). The flow rate of the spherical filter has not yet been tested in comparison to the paraboloid and the flowerpot filters.
3.5.2 Flowerpot Molds

The flowerpot molds produce the standard flowerpot-shaped filter. The flowerpot-shaped filter has a flat bottom that has greater surface area than other round-bottomed filters. The molds are typically made from aluminum or sometimes cast iron. Due to the precision required in fabricating the molds and the need for machinery that can work aluminum, these molds are not usually made on-site. Schematics for the Potters for Peace flowerpot molds can be found in Appendix C.
3.5.3 Paraboloid Molds

Figure 40: Paraboloid male mold (Miller and Watters, 2010)

Figure 41: Paraboloid female mold (Leah Nation, 2010)
The paraboloid molds are used to produce paraboloid, cone-shaped filters. These molds are made of cement and can be fabricated on-site; schematics and further details on the design of the paraboloid molds provided by Prof. Manny Hernandez can be found in Appendix C. The “Mani Press” described in section 3.6.4 is a jack-downwards press designed specifically for the paraboloid molds and can also be fabricated on-site.

3.5.4 Half-Spherical Molds

Figure 43: Wooden half-spherical male mold (Curt Bradner, 2010)
Figure 44: Wooden half-spherical female mold (Curt Bradner, 2010)

Figure 45: Metal half-spherical molds with press (Curt Bradner, 2010)
The half-spherical molds were designed and developed by Curt Bradner for use in filter production facilities in Myanmar and Thailand. Spherical molds have been fabricated from different materials including local tropical hardwood, and have all been made locally. After being pressed, spherical filters must be lifted off of the male mold using a carrier ring (see Figure 46 & Figure 47). A schematic of the spherical mold and the carrier ring can be found in Appendix C.

Figure 46: Half-spherical filter being handled with carrier ring on bottom (Curt Bradner, 2010)

Figure 47: Half-spherical mold in press with steel carrier ring in place (Curt Bradner, 2010)
3.6 Press

3.6.1 Introduction

The press is essential to the filter production process; using a press and mold allows production of filters of consistent quality over those produced by hand pressing on a mold or crafting on a pottery wheel (The Ceramics Manufacturing Working Group 2010).

A custom-designed hydraulic press specific for pressing ceramic pot filters, either manual or run by an electric motor, is recommended by Potters for Peace; they suggest that the initial press be purchased from another factory, but they provide schematics to build the standard, “jack-upwards” type press on-site (Potters for Peace 2010). The Ceramics Manufacturing Working Group states that a press powered by an 8-32 ton hydraulic truck jack decreases labor requirements, and if the press is run with the jack on top, in a “jack-downwards” configuration, labor requirements are further decreased (The Ceramics Manufacturing Working Group 2010). A hydraulic press powered by an electric motor was designed by the RDI-C with on-site construction costs of USD $2300; they state that the use of a hydraulic press increases the efficiency and consistency of the produced filters (Resource Development International - Cambodia 2008). An automatic hydraulic press is also used with the Mani Press in the Pure Water for All facility in Honduras (Hernandez, 2010).
3.6.2 Potters for Peace Press

The Potters for Peace press is constructed using local materials according to the schematics provided by the organization (see Appendix D). The press is powered by a hydraulic truck jack placed at the bottom of the press, underneath the female mold. The male mold is attached to the top of the press.
3.6.3 RDI-C Press

The RDI-C hydraulic press is powered by a 2.2kW motor. Unlike the Potters for Peace press and the press developed by Prof. Manny Hernandez, this press runs on electricity without needing manual labor for the pressing process. Schematics for this press can be found in Appendix D.
The "Mani Press" is a manually-powered press that uses an 8-ton hydraulic truck jack placed at the top, rather than the bottom, of the press. The Mani Press is unique in that the press and the female and male molds are all fabricated on site. The manually operated jack is used to press the female mold down over the male mold. The female mold is mounted on an H-frame that moves vertically up and down inside the main frame of the press. A hand winch is used to move the female mold up and down through a cable. The male mold is mounted on a frame/drawer that moves horizontally in and out below the female mold. Clay is placed on the male mold to be pressed, and after pressing the frame is pulled out to allow the freshly-pressed filter to be removed.

The Mani Press has been described as easier to use than the Potters for Peace press; the Mani Press allows for easier positioning of the female mold relative to the male mold, allowing for centering of the male and female molds to produce filters with even wall thicknesses (Miller and Watters 2010). The Mani Press also requires fewer pumps of the hydraulic truck jack than the Potters for Peace press, and the Mani Press features a spring
mechanism on the jack to reset it to its starting position, whereas the Potters for Peace press must be manually reset (Miller and Watters 2010). Details on the construction of the Mani Press have been provided by Prof. Hernandez and are described in Appendix D.

4 Conclusions and Recommendations

4.1 Conclusions

4.1.1 Discussion and General Conclusions

There are a variety of sources for the equipment required to construct a ceramic water filter factory. While there are options that have been presented to purchase such equipment, and the costs have been provided where known, consideration must be given to the option of constructing the equipment locally, as this cuts down on shipping requirements and allows local servicing if the equipment breaks down. Consideration must also be given to the level of output of the factory and the resources available to the factory, especially concerning the availability and cost of electricity and fuel as well as the capabilities of the factory workers.

As the scope of this thesis concerns selecting mechanical equipment that meets the requirements of the Pure Home Water factory in Ghana, the machines that best meet these needs and requirements will be highlighted.

4.1.2 Hammer Mill Recommendation

Concerning the hammer mill, the Pure Home Water factory requires at least 100kg/hour of output; the Meadows Model 5 meets and exceeds this output (minimum 181kg/hour) while providing a greater amount of flexibility in power options than the other options presented. The Meadows Model 5 can be run off of a gasoline or diesel engine, allowing the limited capacities of the generators available to be put to other use.

4.1.3 Mixer Recommendation

The mixer has multiple adequate solutions; the Bluebird 24S, the RDI-C mixer, and the mixer developed by Prof. Manny Hernandez are much easier to unload and are preferable over the Soldner mixers for continuous operation in a factory setting. While the Bluebird 24S and the RDI-C mixer must be ordered and shipped, Prof. Hernandez’s mixer can be built on site from locally available labor and materials, making local maintenance operations much easier. The RDI-C design does allow for the automatic addition of water to the mix.
4.1.4 Pug Mill Recommendation

There are several options for the pug mill that provide the required output rate of 106kg/hour, but only the Venco 75mm models are ready-made to run off of the 220-240V power produced by the Pure Home Water factory generators available. While the non de-airing Venco 75mm should be adequate, there is the possibility that the de-airing process will produce clay that results in stronger filters. Whether or not there is any effect of the de-airing process on the flow-rate of the filters is unknown.

4.1.5 Mold Recommendation

There is not yet enough data on the advantages and disadvantages of the different filter shapes to develop an informed recommendation on the preferred type of mold; not enough research has been done concerning the effect of the filter shape on the performance and the strength of the filters. However, the paraboloid molds and the spherical molds have both been proven to be able to be produced locally, a desirable characteristic. Since the Mani Press, which is recommended in section 4.1.6, is specifically designed for the paraboloid molds, the paraboloid molds are recommended for the Ghana Pure Home Water factory.

4.1.6 Press Recommendation

The Ghana Pure Home Water factory currently uses both the Mani press and the Potters for Peace press. As previously noted, the Mani Press has been reported to be easier to use, and therefore is recommended over the Potters for Peace press. Like Prof. Hernandez's other designs, the Mani Press can be constructed locally. The RDI-C electric/hydraulic press is a valid option if less manual labor is desired; the Mani Press can also be adapted to use an electric hydraulic system.

4.2 Further Research Recommendations

Further research is needed to catalogue the machinery currently in use by the operational ceramic filter factories around the world. Data should be collected on the specifications of the machines in use to allow proper comparison between the machines available on the market and those that are constructed locally. Much like the Ceramics Manufacturing Working Group has done with their document Best Practice Recommendations for Local Manufacturing of Ceramic Pot Filters for Household Water Treatment, a survey should be sent out to filter factories around the world to collect information on every piece of machinery used and any data and information on the efficiency, ease of use, safety, and maintenance of those machines.

Further research should also be done to determine the effect of certain machines on the properties of the clay, and how those clay properties affect the final filter product. The effect of a de-airing pugmill on filter strength and quality should be determined. Any effect on flow rate and filter efficiency should be recorded. The effect of filter shape on strength
and flow rate should also be further researched, looking at all three of the currently used filter shapes.
Section A-A
SCALE: 1:25
Wiring Details

SCALE: None

Internal Wiring depends on available timers.

220 VAC

Timer for mixer and water injection

Stops timer for second half of mix cycle

Level Switch

Strobe light to signal completion of mix cycle

Steps injection pump
Electrical System

SCALE: Non
## Table of Contents

**SECTION I - GETTING READY FOR YOUR BLUEBIRD STUDIO PUGMILL**
- UNLOADING THE STUDIO PUGMILL

**SECTION II - RECEIPT AND ASSEMBLY**

**SECTION III – OPERATING THE STUDIO PUGMILL**
- SAFETY
- HOW IT WORKS
- HOW TO FEED THE PUGMILL
- HOW TO CHANGE CONSISTENCY
- CHANGING CLAY BODIES

**SECTION IV - HOW TO MAKE DIES**
- HOW TO EXTRUDE
- COMMON PROBLEMS

**SECTION V - EXTRUDING HOLLOW SHAPES**

**SECTION VI – CARE AND CLEANING OF THE PUGMILL**
- CARE OF MACHINE BETWEEN USES
- IF THE CLAY HAS HARDENED IN THE PUGMILL

**SECTION VII – SERVICE**
- MOTOR FAILURE
- FINAL DRIVE COMPONENTS

**SECTION VIII - MAINTENCE**

**SECTION IX – FREQUENTLY ASKED QUESTIONS**

**SECTION X – PUGMILL BREAKDOWN**
TRY OUR WAY FIRST

Hundreds of Bluebird Pugmills are in use around the world by people who use them to eliminate most or all of their hand-wedging.

BEGIN BY LEARNING TO USE THIS MACHINE PROPERLY. ALLOW YOUR SELF TIME TO UNDERSTAND AND EXPERIMENT WITH IT'S FUNCTION AND OPERATION. EACH CLAY IS DIFFERENT AND WILL REQUIRE DIFFERENT PROCEDURES FOR BEST RESULTS! (Whiteware and porcelain clays may behave differently in the machine than do earthenware and stoneware.)

THESE MACHINES WORK!

PLEASE STUDY ALL OF THE MATERIAL AND KEEP THIS IN A SAFE PLACE FOR FUTURE REFERENCE.

1. It is essential that you keep this manual because it is your proof of purchase in the event that you need to invoke the guarantee provisions for any of the drive components

2. If you have the occasion to call Bluebird because of some problem, please have this manual handy for reference.

3. If a problem or question arises which is not covered to your satisfaction in the manual, please contact Bluebird Manufacturing: 970.484.3243

SECTION I - GETTING READY FOR YOUR BLUEBIRD STUDIO PUGMILL

ELECTRICAL REQUIREMENTS:

The Bluebird Studio pugmill should be plugged into a 3 wire, 115 volt grounded receptacle. It is supplied with a 3-wire, 43” (109cm) cord.

UNLOADING THE STUDIO PUGMILL
BE PREPARED TO HANDLE AND MOVE THIS MACHINE TO ITS DESIRED LOCATION. The shipping weight of the 425 pugmill is about 85 pounds. Inside the shipping container you will find:

1 pugmill
1 clay press (with bolts and nuts attached)
1 nozzle
1 extra rubber spider
1 extra spring
SECTION II - RECEIPT AND ASSEMBLY

INSPECTION:

Inspect the crate for obvious damage. If there is evidence of exterior damage, make a note of it in detail on the delivering carrier’s shipping form. As soon as possible after reading through this manual operate the pugmill. You only have fifteen days from the date of delivery to file a claim with the shipping company for damage not noted on the delivery receipt.

UNPACKING and INSTALLING THE STUDIO PUGMILL

Lift the pugmill out of the carton. Remove the three straps which holds the pugmill to the plywood pallet. (Laying it on its side will not damage it)

You will find the 425 pugmill fully assembled with the exception of the clay press assembly and the front nozzle. These have been removed to prevent damage during shipping. Bolt the clay press assembly to the hopper wall (note the correct position of the hinge in figure 1).

Figure 1.
(Pugmill)

For most potters the best location for the Studio Pugmill is near the wedging table or placed instead of a wedging table since it is primarily a wedging tool. It may be mounted horizontally to a sturdy bench or table. A piece of plywood with a notch cut out for the hopper and placed over all or part of the pugmill makes a handy work surface. The plywood may rest on the pugmill and be hinged to a wall behind the machine to allow easy access.
SECTION III – OPERATING THE STUDIO PUGMILL

SAFETY

Safety is a matter of "common sense". It begins with an understanding of the machine and proper operating procedures. Any machine is only as safe as the manner in which it is used. Please abide by the warnings on the "CAUTION" sign on the side of your machine. Keep the sign clean and visible at all times. This machine is not a toy.

Figure 2.

ONLY AUTHORIZED PERSONS THOROUGHLY FAMILIAR WITH PROPER OPERATING PROCEDURES SHOULD USE THIS MACHINE.

BE CAREFUL
KEEP HANDS AWAY FROM MOVING PARTS OF THIS MACHINE AT ALL TIMES.

WARNING
MAKE SURE ALL PROTECTIVE GUARDS ARE IN PLACE BEFORE OPERATING.

IMPORTANT
DISCONNECT THIS MACHINE FROM ELECTRICAL SOURCE WHEN CLEANING, UNLOADING, OR SERVICING. DO NOT RELY ON MOTOR STARTER SWITCH. THIS MACHINE MUST BE PLUGGED INTO A PROPERLY GROUNDED RECEPTACLE.

LOCK THIS MACHINE WHEN NOT IN USE

☐ Keep children from this machine at all times.
☐ Lock the hopper when not in use.
☐ Do not allow other persons to use this machine until they are thoroughly familiar with the proper operating procedures.

WHAT THE 425 PUGMILL CAN DO

The principal function of the Bluebird 425 pugmill is to reclaim or wedge a combination of wet, dry powder and plastic clays. It can also be used with special attachments to extrude solid and hollow shapes.

For best results scrap recycling should be done daily: the scrap from the previous day should be run through with the current day's throwing clay. Scraps work best if they are damp or wet instead of dry.

When wedging with this pugmill most of the clay should be near throwing consistency with a minority of the material being scrap, slurry or water. Clay too wet or too hard does not feed efficiently through the blade system.
HOW IT WORKS

Clay is introduced into the hopper and pressed into the first set of chopping blades. As soon as the clay enters the barrel, removal or air from the clay begins to take place and is completed by the time the clay reaches the first set of pusher blades. These pusher blades force the clay through a rotating shredder. The resulting tearing and shredding action de-lumps the clay.

NOTE: The eccentric-thrust shaft develops a breathing cycle which helps to expel air. As a result the barrel will exhibit a certain amount of movement during operation; this movement is normal and is no cause for concern.

CAUTION
KEEP YOUR HANDS OUT! THIS MACHINE BITES!

HOW TO FEED THE PUGMILL

Throw 1 to 2 pound bites into the hopper. Pull down on the clay press firmly, but avoid excessive pressure, between bites. If it won’t accept clay without heavy force feeding, you may be trying to throw clay that is of a softer consistency than the clay that is already in the mill. Conversely, clay at moisture content lower than 15% is too stiff.

HOW TO CHANGE CONSISTENCY

When the clay in the studio pugmill is softer than desired, firmer clay introduced into the pugmill will force out the soft clay. However, when stiff clay is in the machine and softer clay is desired, the transition must be quite gradual because the stiff clay will not be pushed out by much softer clay. (see CLEANING.)

INTRODUCING GROG

Grog may be mixed in with the clay as you pug it; Proportions are a matter of guess work.

MEASURING THE CLAY

The regular diameter extrusion will weigh approximately one pound per 2 1/4" of extruded length. Homemade clay rulers can easily be calibrated or cutting frames purchased

TRANSFERRING PUGGED CLAY TO THE WHEEL

When throwing the clay directly from the pugmill, it’s important to place the clay the right way up on the wheel head. Note the direction of the spiral that the pugmill imparts to the clay pug and place the pug section on the wheel head so that the throwing action tightens the spiral. An easier method is to shape the pug with the hands and place it horizontally on the wheel.
ADVANCE PUGGING

The pugging of clay in advance is practical. Extrusions may be stored in a plastic bags and cut to weight as needed instead of running back and forth to the pugmill.

CHANGING CLAY BODIES

It is not necessary to clean the pugmill out when changing clay bodies unless some cross contamination is undesirable; for example: changing from stoneware to porcelain. In most cases one clay will force out the other with about 15 pounds of hybrid clay left over. (also see CLEANING.)

SECTION IV - HOW TO MAKE DIES

Dies may be made from 6"x 6" 16 gauge steel blanks (available at a sheet metal shop), 1/8 to 1/2 inch aluminum, 1/2 inch plexiglass, or 1/2 inch quality plywood. Bluebird recommends beginning with plywood as it is the easiest material to work with. After drawing a pattern on the material, drill out the corners. Use a saber saw or cold chisel to make rough cuts, as indicated by the dotted lines in figure 3. Then use pattern files to finish the edges while making sure that no burrs remain.

![Figure 3](Digs)

Keep in mind that smaller die openings create greater degrees of back pressure. Clay that does not get extruded but continuously gets re-pugged due to back pressure will eventually come out short. When extruding small dimension forms, design a die with multiple openings.

Place the die over the nozzle of your pugmill and clamp it on the nozzle flange. You can also drill 3/8" holes, 1 inch from adjacent edge, in each corner, and bolt it to the nozzle flange. Ordinarily you want the center of the die opening to be at the center point of the pugmill nozzle; however, in some instances you may wish to curl or curve the extrusion. This can be achieved by positioning the die off center. The extrusion will curve in the same direction in which the die is off center" the moiré off center the die is, the more pronounced the curve on the extrusion will be.
HOW TO EXTRUDE

After bolting or clamping the die to the pugmill nozzle, start the machine and begin feeding clay into the hopper. A steady, rhythmic rate of feed produces the best extrusions. Feed the clay until sufficient pressure has built up to force out the extrusion. With one hand hold the end of the extrusion as it comes out of the pugmill and with the other hand pull on the clay press. When the extrusion is about 18 inches long, pinch it off at the nozzle, lay it aside and repeat the procedure. When you have completed extruding, smooth the extrusions with a damp sponge and cover until ready to use.

Below is a suggestion given by one of our customers, Douglas Hylan, of Belgrade, Maine, many years ago:

**Figure 4.**
(Extruding)

![Diagram of pugmill setup]

Platform should be 3/4" plywood, 8" wide and any length desired. Slightly longer than cutting frame is good.

- Bench top
- Block of wood may be slid back and forth to raise or lower platform depending on size of extrusion

**COMMON PROBLEMS**

Under certain conditions, solid extrusions can present problems. The following suggestions are provided to assist you in resolving them.

1. Softer than throwing consistency clay will give superior extrusions and cause less drag on the motor.
2. Coarse or un-aged clay will tend to tear more.
3. Smooth, well finished dies are important.
4. Wide, thin extrusions will give considerable trouble. Extrusions tend to be rough because the center of the extrusion is trying to move faster than the outside, causing the outside surface to want to curl outward. Beveling the die, beginning at the edges and reducing the degree of slant in the center, will improve results.
5. Most extrusions using thin dies will be somewhat rough, but can easily be smoothed over with a sponge.
6. A leather or felt wick with a water feed fastened to the die and firmly in contact with the extrusion is the answer to making high quality extrusions in a large quantity. Normal studios would rarely use this elaborate set up.
7. Some clays are not appropriate for extruding, experimentation is the key. For optimum results careful attention to clay plasticity, moisture content and die configuration will be essential.
SECTION V - EXTRUDING HOLLOW SHAPES

An optional 4 1/4” round nozzle and internal die holder allows extruding hollow shapes. The stainless steel internal die holder consists of a 3/8” threaded rod welded onto a 1/4” bar. The bar slides into a slot in the nozzle. When mounted the 3/8” rod extends about a 1/2” beyond the end of the nozzle. Dies of various diameters are held in place on the rod with 3/8”.

Figure 5

HOW TO MAKE INTERNAL DIES

Dies are most easily made from wood and should taper in back as shown in figure 5. The length (minimum of 2”) and taper of the die are important to the compression and the strength of the extrusion. A wooden dowel works very well for making round internal dies. Drill a 1/2” diameter hole through the center of a 2” length and taper the back. Position the dies around the rod and hold it in place with the 3/8” nuts as indicated in the drawing. To make bead blanks insert a bolt rather than the 3/8” threaded rod and drill or weld a small cylindrical wire to the end of the bolt; the wire becomes the internal die.

SECTION VI – CARE AND CLEANING OF THE PUGMILL

IF NECESSARY TO CLEAN MACHINE, DISCONNECT FROM ELECTRICAL SOURCE! DO NOT DEPEND ON THE MOTOR SWITCH! DISCONNECT!

CARE OF MACHINE BETWEEN USES

Except for extended periods of non use, cover the hopper area with plastic. Place a wet sponge against the clay in the nozzle end and cover the nozzle with a plastic bag. Periodically add a cup of water to the hopper. For periods or non use of six weeks or longer, you should clean the pugmill thoroughly.

NOTE: The aluminum alloy cast barrel possesses high strength and shock resistance, but you should exercise reasonable care in handling the barrel while removing and reassembling.

IF THE CLAY HAS HARDENED IN THE PUGMILL

If the clay has become too stiff or too dried out from non use, the easiest remedy is to pour about a cup of water in the hopper and let it set overnight or until the clay softens up enough to allow the pugmill to start.
NOTE: DO NOT TURN THE STUDIO PUGMILL ON UNTIL THE CLAY HAS SOFTENED. DAMAGE MAY RESULT TO THE COUPLING IF YOU TRY TO FORCE TOO STIFF CLAY THROUGH THE BARREL.

CLEANING

1. Let the pugmill run until it has run all the clay out that it will. The addition of one pint of water into the hopper while running will serve to lubricate the barrel and make removal of the remainder of clay easier.

2. NOW SWITCH THE PUGMILL OFF AND UNPLUG IT! DO NOT DEPEND ON THE SWITCH. UNPLUG THE PUGMILL!

3. Remove the nozzle. Remove the four bolts holding the nozzle to the barrel. It is helpful to run a wire between the nozzle and the barrel to cut free the clay.

4. Using pliers remove one end of the spring that maintains tension on the vacuum rod. Push the top of the vacuum rod completely to the rubber bumper side of the barrel slot. In this position it will clear the blades on the shaft when the barrel is removed.

5. Unfasten the four bolts holding the barrel to the motor box.

6. Pull forward on the barrel keeping the rest of the pugmill in place. The barrel should pull loose and clear the shaft.

7. Scrape the blades and the shaft clean of unwanted clay. Check the cam (attached to the blade in front of the shredder screen) for wear.

8. Pressure wash the inside of the barrel if desired.

AFTER CLEANING

1. Replace the barrel and put all the bolts in place before tightening any bolts. Check the alignment of the shaft and barrel. The shaft blades should be an equal distance from the inside of the barrel without touching the barrel. There is enough play in the bolt holes to adjust the barrel. Then tighten the bolts.

2. Replace the nozzle and bolt it to the barrel.

3. Turn on the pugmill and run it to make sure the alignment is correct. If any scraping or rubbing noise is heard realign the barrel and shaft.

SECTION VII – SERVICE

ALWAYS UNPLUG THE PUGMILL WHEN SERVICING OR CLEANING. DO NOT DEPEND ON THE MOTOR SWITCH. UNPLUG IT

GUARANTEE

We guarantee to replace or repair any part which is defective in materials or in workmanship for a period of one year from the date of purchase. If the fault is ours, allowing for reasonable wear and tear, we will make good (except for shipping costs) even if it means sending you a completely new machine or having you return the machine, parts or attachments for examination and repair (our option).

Drive train and electrical components are guaranteed by their respective manufacturers for a period of one year from date of purchase. Should trouble develop with drive system or electrical components, you should contact us and we will help you locate an authorized service center. Repairs made by other than authorized service centers will void the manufacturer’s guarantee.
** IMPORTANT **

ANY MODIFICATION TO BLUEBIRD EQUIPMENT NOT SPECIFICALLY AUTHORIZED WILL VOID ANY AND ALL GUARANTEES. THERE ARE ON OTHER WARRANTIES GIVEN WITH THIS EQUIPMENT, EITHER EXPRESSED OR IMPLIED, OTHER THAN THOSE SPECIFICALLY STATED HERE.

Any modification will not only void the guarantee for this equipment but may compromise the safety of the operator and such modification may inhibit the proper function of the pugmill. To protect your self and keep the guarantee in effect any modification will need to be approved in writing by Bluebird Manufacturing, Inc.

ALWAYS UNPLUG THE PUGMILL WHEN SERVICING OR CLEANING. DO NOT DEPEND ON THE MOTOR SWITCH. UNPLUG IT!

THE PUGMILL GEAR MOTOR

A checklist of the equipment included in your pugmill is contained in this manual.

MOTOR FAILURE

If your motor exhibits unsettling characteristics, e.g. smoke, loud noises or unpredictable behavior, turn it off immediately and unplug it! Check for any other possible sources of the disturbance. If you still think there is something wrong with the motor, remove it from the base by unfastening the four mounting bolts.

Take the motor complete with switch and cord still attached to your nearest authorized service center. Bluebird will be happy to provide you with a list of your nearest authorized service center at your request. Present the service center with the motor and this document as proof of purchase; the motor will be fixed or replaced free of charge during the term of the aforementioned guarantee.

If the service center gives you trouble or does not fix the motor properly or promptly, let us know and we will take your complaint to the manufacturer for prompt service.

HOT MOTOR

During normal operation the motor will be too hot to hold your hand on. High operating temperature of the motor not accompanied by a burning smell or overloading should not be cause for alarm.

FINAL DRIVE COMPONENTS

REPLACEMENT OF THE COUPLING SPIDER

(See illustration on the last page of this manual.)

1. Remove the motor cover shroud.
2. Loosen the set screws in the coupling half and slide it away from the spider.
3. Insert the new spider.
4. Slide the coupling together and tighten the set screws.
5. Replace the shroud.

REMOVAL OF THE COUPLING 71

10
1. Remove the motor cover shroud.
2. Remove the four bolts holding the gear-motor to the base and remove the motor.
3. Loosen the set in the coupling half and remove it.
4. Insert the new spider and/or replace the damaged coupling half.
5. Reverse the above procedure for reassembly.

REPLACEMENT OF THE BEARING

1. Remove the motor cover shroud.
2. Remove the barrel (see the section on cleaning).
3. Remove the two set screws in each of the two bearing inserts. You may put liquid wrench around the insert and in the set screw holes. Allow it to sit overnight.
4. Remove the four bolts holding the gear motor to the base and remove the motor.
5. Loosen the set screw in the coupling half on the main shaft and remove the coupling body and shaft key. Take caution not to lose the shaft key.
6. Remove the main shaft from the front by tapping lightly on the rear of the shaft using a block of wood and hammer. Be careful not to mushroom the shaft end.
7. After the shaft has been removed, loosen the bearing mounting bolts and replace bearing insert.
8. Reassemble by reversing the procedure.
CAUTION: Do not tighten the bearing mounting bolts until you have checked the alignment of the shaft and the barrel.

BARREL ALIGNMENT

The shaft must be aligned to the center of the barrel. Visual alignment is sufficient, however, the placing of wood wedges or flat head screw drivers between the shaft blades and the inner barrel walls will help to insure that the blades do not scrape the inside of the barrel at any point during the shaft rotation. When the shaft is centered, tighten the bearing mounting bolts to hold it in the correct position.

SECTION VIII - MAINTENCE

DRIVE COMPONENTS AND MOTOR

Greasing: The pugmill should be greased every 30 to 90 days. Remove the orange cover (shroud) over the motor area. Locate the front bearing inside the rectangular drive box. The pugmill should be running during greasing. KEEP THE HOPPER CLOSED AND KEEP HANDS CLEAR OF MOVING PARTS. Use a multipurpose lithium based grease. Pump the grease into the grease fitting slowly until a small amount of the grease is just visible at the contact of the bearing collar and bearing seal. It may take several strokes on the first greasing: subsequent greasing may take only a partial stroke. DO NOT OVER GREASE OR PUMP GREASE GUN RAPIDLY as pressure inside the bearing will rupture the seal and the bearing will become contaminated with dirt and fail more rapidly.

The motor requires no lubrication for the life of the motor. Make periodic checks for tightness of bolts and screws; use an allen wrench to check the tightness of the bearing collar set screws. Periodically remove the motor cover to inspect the coupling and check for wear on the rubber spider, the star shaped spacer between the coupling halves, you will see little black rubber pieces inside the rectangular drive box. If this needs to be replaced contact a bearing supply store or Bluebird Manufacturing, Inc.
WARRANTY

BLUEBIRD MANUFACTURING, INC. WARRANTS THE EQUIPMENT PURCHASED FROM US TO BE FREE OF MANUFACTURING DEFECTS IN MATERIALS AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM THE DATE OF SHIPMENT FROM BLUEBIRD TO THE ORIGINAL PURCHASER. COMPONENTS SUCH AS, BUT NOT LIMITED TO, THE MOTOR, ELECTRICAL, AND THE POWER TRANSMISSION PARTS ARE NOT COVERED BY THIS WARRANTY, BUT BY WARRANTIES OF THEIR RESPECTIVE MANUFACTURERS.

CONDITIONS AND LIMITATIONS:

This warranty is void and inapplicable if the pugmill has not been used in accordance with the instructions contained in the owner’s manual or has been misused, abused, damaged by accident or neglect or in being transported, or has been tampered with, repaired or modified by anyone other than Bluebird Manufacturing, Inc.

If a Bluebird Manufacturing, Inc. product fails to meet the above warranty and the above conditions have been met, then the purchaser’s sole remedy shall be to return the product to Bluebird Manufacturing, Inc. where the defect will be repaired without charge for parts or labor.

A RETURNED PRODUCT MUST BE ACCOMPANIED BY A RETURN AUTHORIZATION NUMBER AVAILABLE ONLY FROM BLUEBIRD MANUFACTURING, INC.

The equipment must be packed in the original packing and returned to Bluebird Manufacturing, Inc. via insured freight by the customer at the customer’s expense. After the repair of the equipment, it will be returned to the customer freight collect. The customer is responsible for all freight charges both to and from Bluebird Manufacturing, Inc. in all cases.

MAILING ADDRESS:
Bluebird Manufacturing, Inc.
P.O. Box 2307
Fort Collins, CO 80522-2307

SHIPPING ADDRESS:
Bluebird Manufacturing, Inc.
1421 Webster Avenue
Fort Collins, CO 80524

This warranty is limited to the original purchaser and is not transferable. This warranty expires on the first anniversary of the shipment date. THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, ALL OTHER REPRESENTATIONS TO THE FIRST USER PURCHASE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, INCLUDING LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES. BLUEBIRD MANUFACTURING, INC’S LIABILITY IN ALL CASES IS LIMITED TO THE REPLACEMENT PRICE OF ITS PRODUCT. THIS WARRANTY GIVES YOU SPECIFIC RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.
SECTION IX – FRENQUENTLY ASKED QUESTIONS

Q. How can I get hand wedged quality from the pugmill?
A. You can get results quite similar to hand wedged quality from your pugmill only after you learn the procedure of operation that is relevant to your individual situation. Short or porous clay results from poorly prepared materials or improper operating procedures which trap air inside the pugmill. Very rarely chemical impurities in the water or materials can cause problems which may require adjustments or our assistance. If you have questions, please call us; we are glad to help.

Q. What is wrong if my extrusion seems to be too slow?
A. If the rate of extrusion seems abnormally slow, it may be because you have a stiff clay blockage inside the pugmill while you are trying to put through a softer clay. Try putting in ten pounds or so of a stiffer clay to clear the blockage. Also try cleaning the screen.

Q. Why can’t I get the old bearing off?
A. If you followed all the directions in the “Replacing the Bearing” section and the bearing still won’t come off try using a pipe wrench on the collar of the bearing (not on the shaft). Your goal is to turn the collar independently of the shaft. If that also fails chances are that the bearing is seized onto the shaft and will need to be cut off by a welder. Call Bluebird Manufacturing, Inc. for assistance.
Efficient, compact, and portable, the Bluebird Models 425/440 Pugmills offer high quality wedging, reclaiming and extruding capabilities. Either is ideal when quantity of clay to be processed averages 700 lbs per month or less. Some of the possible applications are:

1. Economical reclaiming in the classroom or small studio.
2. A transitional pugmill for the smaller studio or hobby potter.
3. Test or specialty pugmill for the larger studio.
4. Power extruder when fitted with owner-made dies.
5. A means to reduce physical strain of clay preparation.

Model 425 Pugmill

This model performs the basic functions of pugging, reclaiming or extruding. Over the years, many artists have successfully met the needs of many classrooms and smaller studios or performed as a specialty pugmill in larger production settings. The majority of users find that the Studio Pugmill reduces hand wedging. Functional construction, ease of operation, and low maintenance are essential features of the 425.

Model 440 Vacuum Pugmill

Several factors have made the option of a vacuum system worthwhile to many potters; wide use of commercially cleaned clay, varied and exacting fabrication techniques, and tightening considerations. The Model 440 produces a dense, thoroughly desired clay ready for slabware, throwing or extruding. No additional wedging. Its vacuum system design is the same as that of larger Bluebird Pugmills.

Safety Features
- On/Off switch
- Instructional CAUTION sign
- Clay press fully covers hopper-can be locked with provided padlock
- Totally enclosed drive components
- Complete operating and maintenance Instructions included

Safety in design, operation and maintenance is a continuing goal in all Bluebird clay equipment. Please remember that safety is a matter of common sense and begins with thorough understanding of machines and proper operating procedures. Any machine is only as safe as the manner in which it is used.

Maintenance

None for life of gearmotor. Periodic cleaning, check flexible coupling and bearings for wear, lubricate front bearing, bolts and screws for tightness, Model 440 only - check rod and cam for wear. Owner’s manual includes detailed maintenance instructions.

Figure 51: Bluebird 425/440 Brochure Page 1
Extruding

Solid extrusions are possible with standard nozzle and owner-made dies. Hollow extrusions require a 4 1/4" round nozzle and internal die holder accessory. Manual includes instructions for die-making and using the equipment as an extruder.

Personalized Customer Service

Customer service begins with trying to make sure you buy the piece of equipment which best suits your needs. It continues with complete operation and maintenance instructions as well as technical assistance. Customer follow up, service bulletins and same day shipment on "in stock" replacement parts make Bluebird equipment a bargain long after the sale. Most major credit cards accepted.

Guarantee

We guarantee to replace or repair any part which is defective in material or in workmanship for a period of one (1) year from date of purchase. If the fault is ours, we will make good even if it means sending you a completely new machine or having you return the machine, parts or attachments for examination and repair. (Shipping costs are customer's responsibility.)

Drive train and electrical components are guaranteed by their respective manufacturers for a period of one (1) year from date of purchase. Should trouble develop with drive train or electrical components, we will help you locate the nearest authorized service center. Repairs made by other than authorized service dealers will void the manufacturer's guarantee.

Models 425 & 440

GENERAL INFORMATION

Overall Dimensions
Heigh 8-1/2" (21 cm) • Width: 8-1/2" (21 cm) • Handle 14" (35 cm)
Extraction Diameter 3" (7 cm) • Hopper Opening 5" x 5"
(12 cm x 12 cm)
Finish
Powder coated-not barrel
Output
Wedgeing up to 400 lbs./ hr.
Reclaiming up to 200 lbs./hr.
Installation
Horizontally on a bench (425 & 440)

CONSTRUCTION
Barrel
5/16" thick one piece cast Aluminum
Shaft & Blades
Stainless blades, shaft and internal rotating shredder
Housing
16 gauge steel protects gearmotor
Bearings
Rubberized front bearing
Permanently sealed rear bearing
GEARMOTOR
Description
Totally enclosed • Fan-cooled
• Plugs into any 115 Volt grounded receptacle • Efficient torque and friction characteristics, yielding more power than some 3/4 HP motor-gear reduction systems
• Full one (1) year warranty

Model 440 Vacuum Deairing Components

Vacuum Chamber
U.S. Patent #4336910 • Bolted & sealed on barrel • Clear acrylic cover permits monitoring and removal for cleaning • Integral vacuum gauge • Air release valve on chamber wall
Vacuum Pump
1/12 HP • 115 Volts, 60 Hz • Operated separately from pugmill • Pulls up to 24" Hg • Two-ply diaphragm • Aluminum die-cast body • Limited one (1) year warranty

Mounting
Integral with gear-reducer
Switch
Motor rated
Specifications
1/3 HP (.25 kw) • 115 Volts, single phase • 5.3 Amps, 60 Hz • Heavy duty • Class A continuous duty • 40°C ambient 1.0 service factor • Hardened steel pinion • High speed helical gears • Low speed spur gears

AVAILABLE
OPTIONAL SAFETY SWITCH for shutting off pugmill when hopper is opened

SHIPPING
Weight & Class
Model 425: 85 lbs. (38.6 kg); Class 85
Model 440: 112 lbs. (50.9 kg); Class 85

IF YOU NEED CLARIFICATION OR EXPLANATION ON ANY SPECIFICATION, PLEASE CALL US!

In the interest of providing even better equipment, Bluebird Manufacturing, Inc. reserves the right to make changes in design and specifications without notice or obligation.

Figure 52: Bluebird Model 425/440 Brochure Page 2
Owner’s manual for

Venco 75mm (3”)
Standard and De-airing Pugmill

Venco Products
29 Owen Road Kelmscott, Western Australia 6111
ph +61 8 9399-5265 fax +61 8 9 497 1335
email: venwest@iinet.net.au
www.venco.com.au
NOTES ON THIS MANUAL

The information given in this owner's manual applies to both the standard and de-airing version of the VENCO 75mm (3") pugmill.

For the standard (non de-air) version, please disregard the information given for the vacuum pump and related equipment.

The standard model may be easily upgraded to a de-airing version by using the Venco De-air Conversion Kit. Please see your supplier or contact Venco for further information.

Tools required for assembly:
- 13mm (1/2") spanner
- 16mm (5/8") spanner
- 14mm (9/16") spanner
- small tin of multi-purpose grease

Figure 1: Components of the VENCO 75mm pugmill
UN-PACKING THE PUGMILL

Carefully disassemble the shipping crate and unbolt both the pugmill and vacuum pump from the wooden baseboard. Locate the four rubber feet and fasten to the corners of the black frame using a 13mm spanner.

The pugmill is insured for the unlikely event of damage during transport. Please report any damage to your supplier.

**Important notes**

- The pugmill should be placed on a sturdy table or bench approximately 500mm (20") high.
- The vacuum pump may be located up to 7m. (20 ft) away from the pug.
- The electrical supply should be from a 220-240V, 50-60Hz, single phase 10A outlet.
- Extension cords and any power boards should be rated at 15A

Hint: Venco use waterproof plywood for the shipping crate. This timber may be re-used to make long lasting batts for your potters wheel.

SETTING UP THE PUGMILL

**Fitting the tamper handle.**

Remove the two nuts and washers protruding from the rear of the feed hopper, using a 13mm spanner. Fit the tamper lever bracket to these bolts and secure with the nuts and washers previously removed. See figure 2.

![Figure 2: Attaching the tamper lever](downloaded from www.venco.com.au (manual V1.0))
Setting up the vacuum pump (de-airing models only)
Locate the following parts:
- black vacuum hose fitted with brass union connectors
- vacuum pump filter / water trap
- vacuum gauge
- clear plastic, vacuum chamber cover with gasket
- spare vacuum chamber cover gasket

Hint: It is recommended to smear a light film of grease onto the brass threads before attaching components. This aids sealing and future disassembly.

Pugmill
1. Screw the vacuum gauge onto the brass fitting attached to the rear of the vacuum chamber. To tighten use a 14mm (9/16") spanner on the square brass section adjacent to the thread—do not over tighten. A layer of Teflon tape (plumber’s thread tape) on the thread of the gauge may make it easier to align the gauge as in figure 1.
2. Fit one of the vacuum chamber gaskets onto the posts of the clear plastic cover. Place the cover onto the vacuum chamber. See figure 2.

Vacuum Pump
3. Screw the filter / water trap onto the vacuum pump. The clear bowl should face downward.

4. The black hose connects the pugmill to the vacuum pump. Connect one end to the vacuum pump filter and the other to the fitting next to the vacuum gauge. Use a 16mm (5/8") spanner to tighten.

Figure 3: Vacuum hose and filter location on the vacuum pump
**OPERATION**

**Loading the pugmill**
It is recommended that the feed hopper is loaded with clay about tennis ball size. These should be fed into the hopper onto the side where the blades pull the clay down into the barrel.

*Hint: Each lump of clay should be tamped down with the lever before loading the next piece.*

Operator effort is greatly reduced by continually loading and tamping small pieces of clay rather than completely filling the hopper.

With experience, dry powder clay can be blended with wet clay to produce a homogeneous mixture.

The pugmill and vacuum pump motors are fitted with overload protection. If either unit trips off, wait for the motor to cool and then press the red reset button located near the on/off switch.
When the pugmill is not in use, seal the hopper and nozzle with a plastic bag. This may be made airtight by using an elastic band or some adhesive tape.
Clean out all of the clay if the pugmill is not to be used for over a month. See maintenance section.

**De-airing models**
Leave the vacuum pump running continuously while pugging. The pugmill itself may be turned on and off as required. (If the vacuum pump is turned off during pugging, the clay within the barrel may absorb air.)

There is a small slot in the vacuum chamber, through which air is drawn away from clay inside the barrel. It is normal for some of the clay to be sucked up through the slot and into the vacuum chamber during operation. This clay need only be removed if the chamber becomes full.
To successfully de-air clay, there need only be a small hole from the vacuum chamber into the pugmill barrel.

*Hint: The de-airing slot can be cleared swiftly by quickly flicking the vacuum dump tap on and off.*

For satisfactory de-airing the vacuum gauge should read 90kPa or more. 95-98kPa is ideal.

Some fine porcelain type clays are difficult to de-air. To improve de-airing, slow the rate of flow by blanking off the top of the shredding screen. This may be accomplished by applying a layer of plastic adhesive tape to the top layer of the screen. See figure 4.
This technique may also be used to reduce the clay flow through the slot into the vacuum chamber if this becomes a problem with soft clays. Install with the blanked area immediately beneath the vacuum chamber. Do not blank off more than 50mm (2") of screen height. See the maintenance section for information on removing the shredding screen.

It is important to check the vacuum pump oil level and condition weekly. See the maintenance section for more information.

![Figure 4: Blanking off the shredder screen](downloaded from www.venco.com.au (manual V1.0))
MAINTENANCE

Pugmill maintenance
Venco pugmills are designed to be extremely robust and should reward you with many years of trouble free operation. To ensure this please follow these few simple procedures.

Important before performing any maintenance turn off the pugmill and unplug the power supply cable.

Lubricating the auger seal
An auger seal is fitted to prevent any clay back feeding into the auger thrust bearing. This seal requires greasing after every 50 hours operation. A grease cup is fitted on the rear side of the pugmill – see figure 2. Sufficient grease is injected with half a clockwise turn of this cup.

If this cup is fully screwed in, the cup may need to be re-filled. Remove the cup by fully unscrewing it (anti-clockwise), and fill with multi-purpose grease.

Checking/changing gearbox oil
The pugmill gearbox is filled with high quality industrial gear oil. Under normal conditions this needs to be changed after 10-15,000 hours operation. When the pugmill is used for one to two hours per day, change the oil after 10 years service. Use gear oil with a viscosity class of ISO VG220. (Shell Omala 220, BP Energol GR-XP 220, Texaco Meropa 220, Mobilgear 630)

To drain the gearbox, remove the lowest plug adjacent to the gearbox foot. Use a 5mm hex key to remove the gearbox plugs. To fill the gearbox, firstly remove the oil level plug located approx. 50mm (2") up the side of the gearbox from the black base. See figure 1. Fill via either of the top two filling plugs until oil starts to run from the open level plug.

Disassembling the barrel
It may be necessary to occasionally split the barrel for cleaning or to remove the shredding screen. To do this, remove the single nut located at the rear of the feed hopper and the six bolts around the barrel seam.

Carefully pry the two halves apart, taking care not to scratch the mating surfaces of the barrel halves.

Shredder Screen removal
A stainless steel shredding screen is mounted within the pugmill barrel. In time, the screen may become blocked with grit or other impurities carried with the clay. The barrel must be opened to access the screen for removal and cleaning. Using a pair of pliers grip the infill plate and withdraw away from the auger. The screen may then be rotated until it can be lifted from the auger shaft.

Figure 5: Removing the shredder screen
(shredding mesh installed with mesh facing towards the motor)
If applying tape to the screen in order to reduce flow, apply to the motor side only.

**Hint:** An optional coarse shedding screen is available for use with coarse terracotta or clay containing large amounts of grog.

**Re-assembling the barrel**
Carefully clean and dry the mating surfaces of the barrel halves. Apply a length of gasket tape along each length of the barrel flange, on only one barrel half. An original barrel gasket may be obtained from your supplier, or alternatively two layers of ordinary electrical insulation tape makes a satisfactory gasket.

**Hint:** Before re-assembling the barrel, smear all bolts with a layer of multi-purpose grease. This minimises corrosion and eases future disassembly.

**Note:** It is NOT recommended to use silicone or similar gasket glues to seal the barrel halves. This type of gasket makes it difficult to split the barrel in future.

**Vacuum pump maintenance**
It is important to check the vacuum pump oil level weekly. As the pump operates some oil is carried past the piston rings and exhausted. This is normal and beneficial in keeping the plate valves lubricated and free from corrosion.

Exhausted oil may be collected and re-used. If you wish to do this, connect a short flexible hose to the exhaust port and place the other end into a container.

The vacuum pump has a dip-stick, to check the oil level. Check level with the dip-stick in the unscrewed position and ensure the oil reaches the line indicated on the dip-stick. The vacuum pump should be topped up with SAE30, SAE40 or multigrade 20/40 engine oil. DO NOT use friction-modified oils.

The vacuum pump filter/water trap should be checked occasionally. Clean and drain, by unscrewing the clear plastic bowl. Apply a thin layer of grease or petroleum jelly to the thread on the bowl to aid sealing and future disassembly.

**Hint:** Some clays shed water during the de-airing process. This can be carried back to the vacuum pump as vapour. This mixes with the sump oil, turning it cloudy white. If this happens, drain the oil into a glass jar and replace with new oil. The old oil can be re-used after it separates from the water (the oil will float on top of the water).
# TROUBLESHOOTING GUIDE

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Problem Description</th>
<th>Remedial Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VACUUM PUMP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>milky / cloudy oil</td>
<td>water mixed with oil</td>
<td>drain oil from vacuum pump and replace with fresh oil. Contaminated oil will</td>
</tr>
<tr>
<td></td>
<td></td>
<td>eventually separate and oil may be drained off and reused.</td>
</tr>
<tr>
<td>motor stops running</td>
<td>overload trip protection</td>
<td>check oil level in vacuum pump, wait for motor to cool before restarting</td>
</tr>
<tr>
<td>low/fluttering vacuum</td>
<td>vacuum leak or vacuum pump</td>
<td>clay feed into pug too slow - increase feed rate.</td>
</tr>
<tr>
<td></td>
<td>problem</td>
<td>for more details - see below</td>
</tr>
<tr>
<td><strong>PUGMILL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor stops running</td>
<td>overload trip</td>
<td>overloading the pugmill, wait for motor to cool before restarting</td>
</tr>
<tr>
<td>high pitch squeal from</td>
<td>dry auger seals</td>
<td>(1) Ensure grease cap is full, then screw in while operating until noise stops.</td>
</tr>
<tr>
<td>rear of hopper area</td>
<td></td>
<td>(2) Remove grease cup and clear hole with a piece of wire then do step (1) above</td>
</tr>
<tr>
<td>excess clay being pushed</td>
<td>bridging of vacuum slot</td>
<td>flick vacuum dump trip open/closed quickly to suck clay away.</td>
</tr>
<tr>
<td>into vacuum chamber</td>
<td></td>
<td>clay too soft - change consistency</td>
</tr>
<tr>
<td>reduced clay output</td>
<td>blocked shredder screen</td>
<td>disassemble barrel and remove and clean shredder screen</td>
</tr>
<tr>
<td>hard to push clay into</td>
<td>blocked shredder screen</td>
<td>Note: Dry turnings will quickly block the screen - wet and ball before using</td>
</tr>
<tr>
<td>feed hopper</td>
<td>or incorrect feed method</td>
<td>disassemble barrel and remove and clean shredder screen</td>
</tr>
<tr>
<td>air in clay</td>
<td>loss of vacuum note: gauge</td>
<td>see manual for correct feeding method</td>
</tr>
<tr>
<td>(de-air models only)</td>
<td>should read more than 90KPa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(at sea level)</td>
<td></td>
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</tbody>
</table>

**Notes:**

(a) Check condition of black gasket under vacuum chamber lid - replace if worn or damaged.
Run a bead of soft clay along barrel seam while pugmill/pump operating. This may be cleaned after seal has formed.

(b) A simple method of isolating and testing the vacuum pump alone is to fit the vacuum gauge directly to the inlet of the pump.
This may be done by using additional fittings or a short piece of rubber hose (and two hose clamps). The gauge must be read in a vertical position.
1. Tamper handle
2. Tamper handle grip
3. Tamper handle wooden plate
4. Tamper handle pivot assembly
5. Barrel upper / lower
6. Hopper safety grill
7. Barrel seam bolts (x7)
8. Vacuum slot cover (standard only)
9. Vacuum chamber plastic lid
10. Vacuum chamber lid gasket
11. Vacuum gauge
12. Vacuum chamber lid gasket
13. Grease injector cup
14. Barrel gasket (de-air only)
15. Shredder screen (de-air only)
15a. Shredder screen infill plate
16. Auger (standard or de-air)
17. Auger O-ring seals (x2)
18. Auger support assembly
19. Gear box
20. Motor
21. Base assembly
22. Rubber feet (x4)
Other ceramics equipment available from Venco:

No.6 Compact cone drive, w-seat

No.3 Cone drive

No.5 with hand operated speed lock

No.7 High torque, electronically controlled

87mm and 100mm (3 1/2", 4") de-airing pugmill
Please make sure to read the entire instruction manual thoroughly before initial set-up, operation, maintenance and inspection to ensure proper use.

Please keep this instruction manual in a location that is available to the user.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety precautions</td>
<td>1</td>
</tr>
<tr>
<td>Specifications</td>
<td>4</td>
</tr>
<tr>
<td>List of contents</td>
<td>4</td>
</tr>
<tr>
<td>Installation Instructions</td>
<td>5</td>
</tr>
<tr>
<td>Operating Instructions</td>
<td>6</td>
</tr>
<tr>
<td>Maintenance Instructions</td>
<td>7</td>
</tr>
<tr>
<td>Warranty Provisions</td>
<td>9</td>
</tr>
<tr>
<td>Disposal Method</td>
<td>9</td>
</tr>
</tbody>
</table>
SAFETY PRECAUTIONS

Please make sure to read the entire instruction manual thoroughly before initial set-up, operation, maintenance and inspection to ensure proper use.

Please start using only after you have read the equipment’s function, safety information and precautions.

This instruction manual provides three grades of safety warnings: “Danger”, “Warning” and “Caution”. All precautions described here under which concern to the safety are to be read carefully. Please be sure to follow them.

Danger marking indicates possible death, severe injury or fire if the user disregards the instruction.

Warning marking indicates the possibility of severe injury if the user does not follow the instruction.

Caution marking indicates the possibility of minor or damage if the user operates the pug mill improperly. However, depending on the circumstances, it is still possible to cause severe injury. Please make sure to pay close attention to these warnings.

We call your attention to these warnings throughout the manual using the following symbols:

- Warning: Pay Close Attention
- Do Not
- Please Follow Instructions
DANGER

These are safety precautions regarding installation of pug mill.

### Installation

- Do not set up in a location that is susceptible to rain and water or an area of high moisture. This may cause a fire or failure from electrical shock or electrical leakage.
- Do not overload the electrical outlet. Check the amperage rating of the outlet and of any other equipment that may be on the same circuit. A fire could result from overloading the circuit.

### Operation

- Do not let anyone operate the pug mill without proper instructions and supervision. Please assign a specific person to supervise the use of the pug mill in facility where many people operate the unit. Make especially sure not to let children operate the pug mill.
- Do not insert hands. Please do not insert hands into the clay hopper or clay nozzle. Serious injury could occur.
- Be careful of clothing. Loose fitting ties, aprons and other clothing may hang into clay hopper clay nozzle and become entangled in the internal moving parts causing serious injury.
- Secure long hair away from pug mill. Serious injury may occur if a person’s hair becomes entangled in the internal moving parts.
- Do not operate any switches with wet hands. This may cause an electrical shock if you operate switches or plug/unplug cord into the power outlet.
# MAINTENANCE

## Maintenance
These are safety precautions regarding the maintenance of pug mill.

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch the power off</td>
<td>Before doing any inspection, unplug the power cord.</td>
</tr>
<tr>
<td>Unplug the power cord</td>
<td>Carefully by pulling the power plug, not the power cord.</td>
</tr>
<tr>
<td>Do not use damaged power cord</td>
<td>Please do not use damaged power cord, damaged plug or worn power outlet.</td>
</tr>
</tbody>
</table>

## WARNING
Installation
These are safety precautions regarding with installation of the pug mill.

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place the pug mill on a flat horizontal surface.</td>
<td>Be careful with handling since this product is heavy.</td>
</tr>
<tr>
<td>Please make sure to place pug mill unit on a horizontal surface since bumps and slopes may cause vibration and noise. Please make sure to tighten the lock nut on the adjustable leg after adjusting the height.</td>
<td>Please handle pug mill with extreme care since serious injury can occur if the unit should fall on (hands or feet) body parts.</td>
</tr>
</tbody>
</table>

## CAUTION
Operation
These are safety precautions regarding with operation of the pug mill.

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please turn the power switch off if you will not be using the pug mill for an extended period of time.</td>
<td>Do not pour water on pug mill to clean it.</td>
</tr>
<tr>
<td>If you will not be using the pug mill for a long period of time please switch the power off and unplug the power cord from the outlet to prevent damage from possible power surge such as a lighting strike.</td>
<td>Please do not pour water on pug mill to clean it. This may cause an electric short or damage to the pug mill. Clean off pug mill with a damp cloth. The clay hopper, screw case, and nozzle are washable only after disassembly.</td>
</tr>
</tbody>
</table>

## Maintenance
These are safety precautions regarding the maintenance of pug mill.

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not pull on the cord when you unplug the power cord. This may cause damage to the cord and/or plug, which could also, result in a fire created by an electric short or injury from an electrical shock.</td>
<td>Please do not pour water on pug mill to clean it. This may cause an electric short or damage to the pug mill. Clean off pug mill with a damp cloth. The clay hopper, screw case, and nozzle are washable only after disassembly.</td>
</tr>
</tbody>
</table>
SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>NRA-04 Weight</th>
<th>NRA-04S Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>25 1/2&quot; (40&quot; Including Plate) x 12&quot; x 22 1/2&quot; Height</td>
<td></td>
</tr>
<tr>
<td>Anger Rotation</td>
<td>144 lbs</td>
<td>166 lbs</td>
</tr>
<tr>
<td>Motor</td>
<td>20 rpm / 60Hz</td>
<td>20 rpm / 60Hz</td>
</tr>
<tr>
<td>Extruding Capacity</td>
<td>200W 4P Single Phase 115V</td>
<td>200W 4P Single Phase 115V</td>
</tr>
<tr>
<td>Structure</td>
<td>200W 4P Single Phase 115V</td>
<td>200W 4P Single Phase 115V</td>
</tr>
<tr>
<td>Anger material</td>
<td>Twin Anger</td>
<td>Twin Anger</td>
</tr>
<tr>
<td>Anger Case Material</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Nozzle Diameter</td>
<td>3 1/2&quot;</td>
<td>3 1/2&quot;</td>
</tr>
</tbody>
</table>

LIST OF CONTENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Housing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Clay Roller Shelf</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hopper Cover</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Front Cover</td>
<td>1</td>
<td>Cover for Clay Hopper</td>
</tr>
<tr>
<td>Wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Double-head Wrench</td>
<td>1</td>
<td>Cover for Nozzle Opening</td>
</tr>
<tr>
<td>Allen Wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bolt</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Instruction Manual</td>
<td>1 each</td>
<td></td>
</tr>
<tr>
<td>Warranty Card</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>M10 x 1&quot; for screw case removal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Pug Mill Diagram

![Diagram of Pug Mill](image_url)
**Installation**

1. Remove the front cover and hopper cover.
2. Place the roller clay shelf in front of the nozzle.
3. Loosen lock nut on adjustable leg.
4. Set the adjustable leg level on the pug mill and allow all four feet on frame to touch the surface.
OPERATION

Operation

Precautions

* Do not operate any switches with wet hands.

* Do not insert hands or body parts into any opening on the pug mill.

* The breakers may shut down by overloading if you forcibly operate the lever. (Operation of Breaker, refer to P 8).

* In the event that dry clay remains in the clay hopper, please remove the nozzle and clean the internal parts. (Disassembly Procedures, refer to P 7).

*Please do not put a chunk of dry clay or clay refuse into the clay hopper.

* Before placing clay into the hopper clay, please be sure to add water into the clay in order to put in the condition that you can knead by hands. Otherwise, screw may stop and clay may not mix well.

1. Switch the power on.
2. Pull the lever up (screw stop). Place clay into the clay hopper in small amounts.
3. Pull the lever down (screws rotate).
4. When the lever is all the way down it can be lifted back up to place more clay in clay hopper. Continue with this process until you have proceeded all of your clay.
5. Switch the power off when you are finished processing clay.
6. Pull the lever down.
7. Unplug the power cord from the outlet.

After Operation

1. Pull the lever down and install the hopper cover over the clay hopper.
2. Install the front cover over the end of the pug mill nozzle.

Precautions

*Never operate the pug mill with dry clay remaining in the main body.

*When total cleaning of the pug mill is desired clean internal parts of the main body by following the disassembly procedures (Disassembly Procedure, refer to P.7).

Please do not leave clay in the main body for a long period if time. Just in case dry clay remains in Drive housing, do not operate the pug mill in such a condition. Please disassemble the pug mill and remove the clay (Disassembly Procedures, refer to P.7).
MAINTENANCE

■ Cleaning

* When total cleaning of the pug mill is desired clean the internal parts of the main body by following the disassembly procedures.

■ Disassembly Procedures

1. Switch the power off.
2. Unplug the power cord from the outlet.
3. Remove the hopper cover and front outlet.
4. Remove two nuts that secure the nozzle to the screw case using the wrench supplied. Then remove the nozzle from screw case.
5. Remove the four bolts that secure the clay hopper to the screw case using the wrench supplied.
6. Remove screw case by detaching four nuts that secure the screw case to the drive housing using the wrench supplied.

Precautions

* Rinse each of the disassembled parts with water and dry them well. Do not disassemble parts, which are not described, since this may cause the pug mill to fail and will void the warranty.

Disassembly Diagram

In the event that it is difficult to remove hard clay remaining in screw case for an extended period thread the 1" bolt into the tapped holes at the rear of the screw case to gently pry the screw case from the drive housing.

■ Oil Inlet Opening

1. Pull the lever down and install the hopper cover over the clay hopper.
2. Install the front cover over the end of the pug mill nozzle.

Precautions

* Fuel oil or grease is not suitable for lubrication.
* Please do not inject unknown substances or water into the oil inlet opening.
Assembly Procedures

1. Install the screw case into the drive housing and tighten with nuts for attaching the screw case.
2. Install hopper onto the screw case and tighten with bolts for attaching the clay hopper.
3. Install nozzle onto the screw and tighten with nuts for attaching the nozzle.
4. Pull the lever down, plug the power card into the outlet, and switch the power on. Check for unusual sounds. Recheck assembly if necessary.

Trail Operation

1. Plug the power cord into the outlet.
2. Do not set anything into the clay hopper, pull the lever down, switch the power on, and then allow the unit to run for a short time.
3. Check if the pug mill has any vibration, rattles, or unusual sounds (If none then proceed to the section on operation).
4. Switch the power off and unplug the unit.
5. Make adjustments to level and position the pug mill.
6. Return to step one.

Precautions

*Do not operate any switches with wet hands.
*Do not insert your hands into any pug mill opening.

Operation if Breaker

The breaker will not shut off under normal use. If you forcibly push a large amount of clay, or hard clay, into the hopper it will cause the breaker to shut off the pug mill. In the event that the breaker shuts off the pug mill will stop. In this case press the breaker switch inward, the breaker switch is under a waterproof cap. Do not remove the water cap. Press the breaker with the cap in place.
WARRANTY PROVISION

Cleaning

*Shimpo warrants that this product shall be free from defects in workmanship and materials under normal use and proper maintenance for the warranty period specified providing that you follow the instruction manual and information printed on the label attached to the main body.

*The following cases are not covered under the warranty:

Breakdown or damage caused by misuse or alternation.

Breakdown by damage caused by dropping the unit.

Breakdown or damage caused by fire, earthquake, flood damage, power surges and other natural disasters.

Breakdown or damage caused by public pollution, gas, pollution, salt damage, and unusual electric disturbances.

Changes in apparent condition such as scratches obtained through use and storage.

Failure to submit the warranty card.

*Please keep the warranty card in a safe place. Warranty cards will not be reissued.

*The warranty card guarantees free repair through the warranty period for repairs falling within the terms of the warranty. If you have any questions about repairs after the warranty period, please consult an authorized Shimpo dealer or feel free to contact Nidec-Shimpo America Corporation directly.

*Please become familiar with the terms and conditions of the warranty.

DISPOSAL METHOD

*Please consult with local government since the disposal method for the pug mill is different in each local government.

*Please do not disassemble the pug mill when you dispose of it.
1. Assign a designated person to supervise the safe and proper use of the pug mill in facilities where the unit will be used by more than one person. Restrict the use of pug mill to only properly trained individuals.

2. Do not let children operate the pug mill.

3. Do not insert your hands into any opening in the pug mill.

4. Switch the power off and unplug the power cord from the outlet when you clean and disassemble. Never rotate the motor while disassembling.

5. Do not wear loose fitting clothing like neckties or aprons, which may get caught, in the moving parts in the pug mill.

6. Secure long hair up and away from the pug mill.

7. Do not operate any switches with wet hands.
Product by

NIDEC-SHIMPO AMERICA CORPORATION
Appendix C: Mold Documents

Potters for Peace Flowerpot Mold Schematics
This drawing is a layout of the cement molds that were made at Slippery Rock University (SRU) in Slippery Rock, PA in the summer of 2008. The prototype filter (PF) was made there and two sets of cement molds were made from the same PF.

An outline of the PF was made securing a piece of plywood at right angles to a table top and the rim was secured to the plywood with "C" clamps. A piece of craft paper was taped to the table top just beneath the suspended PF. A carpenter's square (CS) and a marker were used to project a vertical line down from the edge of the PF. Dots were drawn about every 1 inch at the base of the CS as it was moved around the perimeter of the PF. After the last dot was completed, the dots were connected together. This formed the outside outline (shape) of the PF.
The inside shape of the filter was arrived at by drawing a series of dots about 3/4 inch away from the outside outline of the PF. These dots were then connected and the whole image of the filter was trans-formed as a cross section view as if the PF was cut in half.

The rest of the drawing information shows the thickness of the concrete mold on the outside of the PF. On the inside of the mold, the male mold (MM) is shown. A cavity is on the inside of the mold so that it will not weigh so much. A “donut” bat is also incorporated along with the plywood base mounting that is the actual mount for the MM when it is placed on the Mani filter press.

This drawing gives all the information necessary to construct the female and male cement molds for pressing out the filters.

This drawing has all the information necessary to make the metal retainers (cones) that will be used to form the female mold (FM). The interior of the PF is used to form the male mold (MM), however, a cone is necessary to form the core that will be used to create the negative area inside the MM. Half inch threaded rod is shown imbedded in the concrete. These will be used to mount the MM to the filter press.

The reinforcement wire cage is also shown midway between the outside edge of the FM and the outside edge of the cement mold (CM). At the base of the wire cage is the 3/32 X 1- 1/2 inch thick metal ring. This ring will be embedded in the concrete and is used to cut off the excess clay that oozes out from the CM after each filter is pressed.
At the top of the wire cage, the 1/2 inch threaded rods (4 in all mounted on the top ring) are welded to the top ring of the cage. They, as can be seen, will be embedded in the cement, also. At the very top of the female mold is a core. It is made from a foam cup and is held in place touching the FM as the cement is poured. It is removed after a day and the hole that is left is used to knock the PF away from the FM.

Two things that should be noted, first, the outside metal cone that will retain the cement around the FM is secured to the plywood base of the total unit as the cement is being poured around the FM. Secondly, Vaseline should be applied to the inside and outside of the PF before everything is assembled before pouring the cement. Applying the Vaseline will act as the release agent when disassembling the entire unit after the cement has been poured and has set. After the molds have been separated they are cleaned then placed under water for curing.
Spherical Mold Diagram

FEMALE SECTION OF MOLD

This is the ring. .063 to .125 thick .093 is preferable.

Steel sleeve to drive pin in female half of mold

6.0 radius

7.5 radius

Added 1.5 inches to depth of filter to increase filter capacity by approximately 2.5 liters for a total capacity of 10 liters. 25-3-47 ch

Don't forget 2 to 3 degree draft.

.375 radius

.750 (thickness above ring)

16 inches

Note: Mold halves must be aligned with steel pin located in two places.

Steel pin should penetrate at least 4 inches deep into female section.

MALE SECTION OF MOLD

Ring: Outside diameter cannot exceed filter diameter.

Inside diameter should remain the same as current filter mold, 25-3-47 ch.

ALL DIMENSIONS ARE IN INCHES
Carrier Ring Drawing

17 inch outside diameter

13.6 inch inside diameter

.093 to .125 thick depending on availability. (.093 is preferable)
Appendix D: Press Documents

Mani Press Instructions by Prof. Manny Hernandez

The Mani Press and How it Function

The Mani press is designed to be operated manually since most of the time it will be used in areas that are off the power grid, or if there is power available sometimes there are long periods of power outages.

The parts of the press are the main frame (A) which is the vertical support for all of the parts that make the press; the moveable (horizontal movement) table (B) that is used to mount the mail mold; the female mold support (C) or “H” frame that moves vertically within the main frame; the trolley (D) that moves horizontally on top of the frame has a pipe welded to the bottom of it; the hand winch (E) with cable and is used to lift and lower the female mold during the pressing operation. The cable of the winch rides freely over to grooved wheels located at the top of the main frame and is attached to the “H” frame.

A). Main Frame

The frame is made of 2” angle iron. The two sides are made out of 2 pieces of 2” angle welded into a “U” shape. It is advised to clamp the 2 angles together before welding so that the sides remain straight and not buckled in or out. The heights of the sides are 70” to 72”.

Two pieces of angle iron are welded to the top of the two sides facing down. The dimensions for the two top angles are 28 inches. This will leave 24” between the 2 vertical supports. Because the sides of the frame have a dimension of 4” when welded together, there will be a separation between the two top angles of approximately 1/2”. This groove will serve as the space needed for the trolley and the cable to go through. These two top angles are squared to the side frames and welded.

At the bottom of the side frame two 2” angles are squared and welded to the bottom of the side frames which. These angles face away from the bottom frame. This allows the “H” frame that the female mold is mounted to, to slide in or out from the bottom if it needs to be removed or inserted.

At the very bottom and sides of the frame, two- 2” angle irons, 30” long are faced away from the sides, centered, secured with clamps at the bottom and squared. After they have both been squared, they are welded in place. These two angle irons form the support for the main frame. On the ends of the feet, about 2” in, adjustable levelers are added made from 5/8” diameter threaded rod. Holes are drilled to fit the 5/8” threaded rod. The nuts from the threaded rod are welded to the angle iron which will be the thread for the threaded rod. At the bottom of the threaded rod a nut is also welded. A large heavy duty flat washer is then welded to the nut. The weight of press will be supported by these 4 adjustable feet.

B). Male Mold Support

The support has two parts. One is the support for the sliding frame that holds the male mold which moves the male mold out from under the female mold. In the out position it allows the filter to be removed and also for placing the clay onto the male mold before being pushed in again under the female mold. The sliding frame also is the anchor for the
plywood disc that holds the male mold. This disc which is attached to the male mold can be moved in either direction to center the male mold directly under the female mold.

The support for the moving table is made from 1 1/2” angle iron. Its width is the inside width of the main support, 24”. Its depth is 18”- 20”. This unit is made to be removable in case the “H” unit has to be removed for any reason. It is mounted so that 10” protrudes beyond the back of the main frame. It is then secured to the main frame with nuts and bolts. The front side of this frame, the angle iron faces down so that the sliding frame can move back and forth.

The moveable frame that the male mold is mounted to is made of 1 1/2 inch square tubing. Its dimension is 24” front to back and it width dimension, which slides on its respective mount beneath it, is the inside width of the bottom support minus about 1/8”.

C). The Female Mold and Hydraulic Jack Support

This support is made from 1- 1/2 “ angle iron. The two horizontal pieces are welded together and face down. The two side supports are also 1- 1/2 “ angle iron and welded into a “U” shape. These are the vertical supports and they slide up and down between the main support. The box frame made from 3/4” angle iron is the support for the hydraulic jack is attached to the top of this “H” unit. When the hydraulic jack is placed in its support frame, the jack is centered on the “H” frame and not the jack support frame since the jack is asymmetrical. The support for the female mold is attached to the underside of the “H” frame.

D). Trolley

The trolley is made up of four 3” diameter wheels which are mounted to an inverted “T” frame that fits and slides in the groove at the top of the main frame. With the wheels mounted to the “T” frame, a 1/8” clearance is allowed between the “T” frame and the underside of the top of the main frame support. The bottom of the inverted “T” has to be reinforced with about a 1/4” piece of metal as does the sides of the top of the main frame. For the sides of the main frame, appropriate sized angle iron can be used. The top side of the main frame and the trolley are under constant high pressure produced by the hydraulic jack.

At the bottom of the trolley a reinforced pipe is welded to it. When the female mold is in the down position ready for pressing a filter, the trolley is moved over the hydraulic jack. Because the trolley has a stop welded at the top of the frame it centers itself over the jack. The trolley and the pipe welded to it takes up the space between the top of the jack and the underside of the top of the main frame. When the jack is operated it immediately works against the pipe on the trolley which works against the underside of the main frame and proceeds to push the female mold down to press out the filter.

E). The Winch and Cable

The winch is a hand crank with a built in ratchet and lock. It is best mounted on the side of the main frame so that it is operated as the operator faces it from the front of the press. The cable rides on two grooved wheels located on the top of the main frame. The outer side of the inner wheel is placed so that the cable going through the main frame lines up with the right side of the hydraulic jack mounting frame. Because the winch comes with an excessive amount of cable (32 feet to be exact), most of it is cut off. There should be just enough cable with a little slack left when the female mold is in its complete down position. The cable
should be cut with an arc welder otherwise the strands of the cable will be frayed and will injure someone; the arc welder welds the end of the cable nicely as it is cutting the cable. The winch usually has to be brought in from the states because they are difficult to find where the project is being initiated. The winch can be purchased from Harbor Freight Tools. It is a 1000 lb capacity hand winch, item #65688.
INSTRUCTION MANUAL FOR FABRICATION THE PRESS TO MAKE FILTERS

Principle parts for making filters:

1. Frame
2. Support for hydraulic jack
3. Handle
4. Male Mold
5. Female Mold
6. Support for female mold
7. Hydraulic Jack

Dutch Press Schematics
I. FRAME

FRAME PIECES

1. Profile in "C" (4"x2"). Length = 508mm (2 Pieces)

2. [Dimensions and measurements shown]
1. Frame continued (pieces of the frame)

**Pieces of the frame**

- **3**
  - 1 piece
  - Male mold centered on piece #3
  - And welded to frame (top view)
  - Line up holes and weld Plates with the male mold as

- **4**
  - 1/4 inch plate. 2 pieces
  - Length = 950mm

- **5**
  - Profile in "C" (4" x 2").
  - Thickness = 8mm
  - Length = 1500mm (2 Pieces)
  - 2 agujeras $\phi_{1/2}$

- **6**
  - 1/4 inch smooth rod
  - Length = 1500mm (2 pieces)

- **7**
  - Profile in "C" (4" x 2").
  - Thickness = 8mm
  - Length = 508mm (2 pieces)

- **8**
  - Angle 2" x 2"
  - Thickness = 4mm
  - Length = 750mm
  - Round off edges (2 pieces)

- **9**
  - Profile in "C" (4" x 2").
  - Length = 180mm (1 Piece)
  - Drill 1/2" hole in center of Face plate

- **10**
  - Angle "1" x 1".
  - Thickness 3mm
  - Cut 2 right pieces and 2 Left pieces

- **11**
  - Angle 1 1/2" x 1 1/2".
  - Length = 254
  - Thickness = 5mm (1 piece)

- **12**
  - 5/8" Galvanized Tube
  - Length = 30mm
  - Align with hole from #9
2. Support for the Hydraulic Jack

Mounting Diagram

Pieces for the hydraulic jack

14. Profile "C" (4" x 2"). Length = 180. (1 Piece)
15. Angle 1 ½" x 1 ½". Length = 164mm. Thickness = 5mm (2 pieces)
   *Cut one straight piece and one left angle
16. Angle 1 ½" x 1 ½". Length = 197mm. Thickness = 5mm (4 pieces)
17. Angle 1 ½" x 1 ½". Length = 180mm. Thickness = 5mm (2 pieces)
18. Angle 1 ½" x 1 ½". Length = 180mm. Thickness = 5mm (4 pieces)
19. ⅜" dia. Galvanized Tube. Length = 210mm (2 pieces)
3. Handle

**Pieces of the handle**

- **20** 1" Dia Galvanized Tube. Length = 1340mm (1 Piece)
- **21** 1/2" Dia Galvanized Tube. Length = 450mm (1 Piece)
- **22** 1/2" Dia Galvanized Tube. Length = 450mm (1 Piece)
- **23** 3/4" Dia Galvanized Tube. Length = 40mm (2 Pieces)
- **24** 3/4" Dia Galvanized Tube. Length = 100mm (1 Piece)
- **25** 1" Dia Galvanized Tube. Length = 40mm (3 Pieces)
- **26** 1" Dia Galvanized Tube. Length = 50mm (6 Pieces)
- **27** Plate 58 x 25.4 mm x 3 mm (1 Piece)
- **28** 3/4" x 3/4" angle section. Length = 25.4mm (1 Piece)
- **29** 3/4" Dia Galvanized Tube. Length = 170mm (2 Pieces)
Bibliography

UNICEF; WHO. "Diarrhoea: Why Children are Still Dying and What can be Done." 2009.