

Farmer Built Spelt Dehuller

Construction Manual



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Introduction:

The object of this grant was to design and build a dehuller that would allow a small farmer to dehull his spelt. This machine is designed to dehull and has been tested with spelt and emmer. It should also be able to dehull einkorn.

This machine took ~215 hours and ~\$13,000 to build. Over half of the cost is in the electronics.

Merits of building your own equipment:

As a small farmer there is often equipment that you would like to have but can not justify the cost of purchasing. Often specialized equipment is relatively expensive due to low production quantities. Since there is often no economy of scale for specialized equipment manufacturing, a financial savings can be realized by the farmer who builds his own equipment. Also by building your own equipment, you can incorporate all of the features that are needed for your operation.

But keep in mind by building your own equipment, you won't be able to pick up the phone and order spare parts. So when you are building your machine you will want to make extra replacement parts for the most common wear items. Also you should keep copies of all of the plans and records of all of the components you bought to make repairs easier down the road.

What you will need to build this machine:

Before you begin to build this machine price out all of the components and talk with a reliable local industrial control electrician. Make sure that the total cost of the machine is acceptable to you before you begin to build it.

Make sure you incorporate any safety features that you think are necessary. For example I have an emergency stop button on the main control panel and a limit switch which prevents the machine from being operated with the front cover removed.

The machined parts can be made by a local machine shop. A magnetic drill press is very handy to drill holes on the back plate of the dehuller and also for the numerous holes you will have to put in the electrical enclosures.

I used both a MIG and a TIG welder (because I had them) if you don't have a TIG welder you can get by with a MIG welder (you might have to grind a little more to make the welds look pretty).

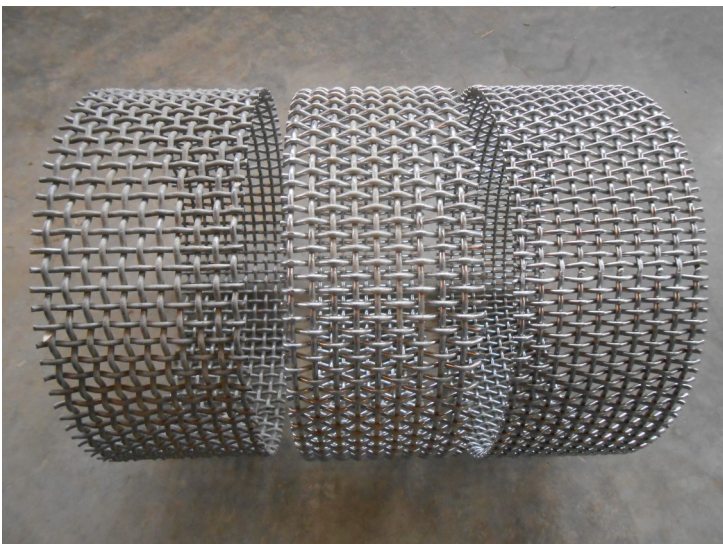
Once again, make sure you have the electric parts (and who will be hooking them up) figured out before starting. If you do not wish to electrify this machine, I have some ideas of how to run the dehuller with a tractor at the end of the book .

Overview of the Dehuller



The grain starts out in the machine's hopper. A sliding gate regulates the feed and an agitator prevents the spelt from bridging. There is a brass door with a ceramic magnet to capture any metal before the grain enters the dehulling chamber.

The dehulling chamber has a 4" deep x 10 1/8" diameter wire cloth screen around the outside. The hulled grain is moved along this screen by hammers until the hull is peeled off and the grain can fit through the screen. The hammers are driven directly by a 10hp motor whose speed is controlled by a variable frequency drive.



Depending on the size of the dehulled grain, you have to use different size screens. I had three screen sizes made. The one on the left is a commercial 1/4" x 1/4" space cloth. The middle screen was custom woven for spelt. The screen on the right was custom woven for emmer, small grained spelt and will possibly work with einkorn. If you are building a dehuller, I can sell you screens to save you the expense of having them custom woven.



The aspirator is a simple air column that the grain falls through. The air is set so that most of the hulls are removed but the grain is allowed to fall out of the bottom of the aspirator. Getting rid of the hulls makes the next step, separation, easier.

This dehuller does not separate. An additional piece of equipment, a gravity table pictured in the background, will be required. A seed cleaner or a paddy table could also be used.

A radial blade fan mounted behind the main control panel provides the suction that makes the aspirator work. The fan's motor speed is controlled with a variable frequency drive that allows the separation of the aspirator to be very finely adjusted.



About the dehulling:

Dehulling consists of three steps, dehulling, aspiration and separation. The first step dehulling was traditionally done by friction using special dressed millstones to peel the hull off. There are some modern dehullers that use rubber disks to achieve this same affect but have a very low throughput. Some large commercial operations use impact dehullers which have an impeller that throws the grain against a ring at a high speed. These dehullers while having a high throughput but also crack or break a lot of grain which requires additional equipment to remove these broken grains. The style of dehuller I built is similar in concept to those built by two separate German firms. It runs a layer of dehulled grain around the screen at a high speed. As the grain goes around the screen through abrasion with screen and other grain the hull is gently peeled off. Once the grain is dehulled it can fit through the openings in the screen.

Once grain is dehulled the hulls need to be separated from both the good grain and the grain that is still hulled. This is done by passing the grain/ hull mixture through an air stream. Known as an aspirator, this machine uses air to perform a rough density separation and suck the lighter hulls away.

My design incorporates both a dehuller and an aspirator in one unit.

The last step in the dehulling process is separation. The good grain needs to be separated from the grain that still retains its hull. The hulled grain then needs to be rerun through the dehulling machine mixed with virgin hulled grain.

For a small farmer looking to get milling grade spelt, a grain cleaner with properly sized screens can produce a satisfactory product. If there are some grains still retaining their hull, when you are milling a whole grain flour, the flour can be sifted through a coarse screen that will allow the bran to go through the screen but exclude the large hull pieces.

If you want to produce spelt berries you need to use a gravity table or paddy table. This is how larger operations separate the hulled from dehulled spelt. Both the gravity table and paddy table are able to finely separate the grain by its density.

Operating the dehuller:

The machine is turned on in reverse of the grain flow. The aspirator is turned on first. Then the dehuller. Next the agitator is turned on and then the feed gate is opened.

You want to use a motor speed for the dehuller that gives you good throughput but no cracked grain. For normal spelt, I found that 1400 rpm was best. With small spelt and emmer that was harder to dehull I increased the speed to 1600 rpm. Keep increasing the aspirator speed till a couple of the smallest/lightest grains start to come through and then back off of the speed a little. The feed gate should be opened slowly. Watch the percent of load on the motor and don't exceed 75% as the feed tends to surge. Make a mark where you find that the best feed rate is so that you can repeat it in the future.

In your search of the internet, you may see that some of the smaller German dehullers don't have variable frequency drives. This is because they have 50hz electric. My motor which spins at 1,780rpm with 60hz would be 1,480 rpm with 50hz. 1,780rpm is too fast and will crack grain. I used variable frequency drives on my dehuller motor and aspirator motor, as people I talked to that had this style dehuller advised me to avoid belts and use direct drive as the belts always seemed to slip and burn out.

With the larger spelt that I dehulled, I did not need the 10hp motor, a 7 1/2hp motor would have been adequate. But, the smaller spelt and emmer I dehulled, required the 10hp motor. So, I would recommend building your machine with a 10hp motor.

If you don't have three phase power I recommend using a digital phase converter. A rotary phase converter's voltage isn't stable and this can damage the variable frequency drives.

About the Electronics:

My dehuller's electronics were spec'd by my electrician and local electrical supply houses. I used Baldor motors for the dehuller and aspirator, ABB variable frequency drives and Allen Bradley for most of the other components. My electrician went AWOL when it came time to wire the machine so I ended up doing it myself. Due to the complexity of all of the components, it took me 44 hours to wire the machine. I had a service technician from the local electric supply house come out and help me program the variable frequency drives. Rather than spec out what I used I am going to describe the different circuits and you and your electrician can use components that are readily available in your area. Be sure that your electrician will follow through with the installation.

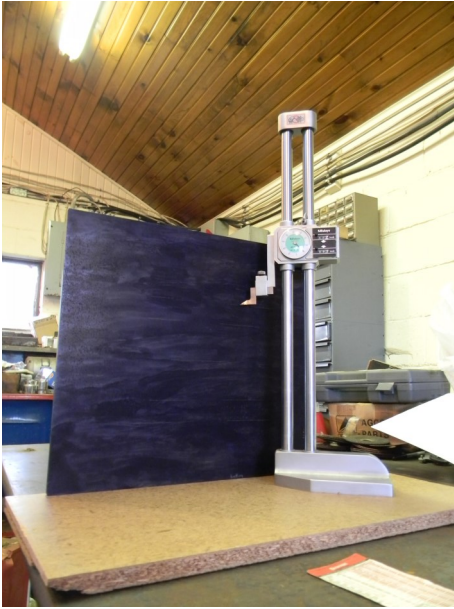
- 1.) The power comes in to a 30 amp IEC style internal fused disconnect.
- 2.) The power goes to an Emergency stop contactor. This circuit has an E-stop button on the main panel, a limit switch on the dehulling chamber (so the machine can't be run when the front cover is removed) and a thermal switch on the dynamic brake.
- 3.) A transformer for the control voltage gets its power from the input side of the emergency stop contactor. In addition to the controls, this transformer also powers the fans that cool the electric enclosures.
- 4.) After the emergency stop contactor, a power distribution block divides the power for the different circuits.
- 5.) The variable frequency drive for the main motor also has a dynamic brake to dissipate the excess electric generated when the dehuller motor freewheels as load is removed, if the grain flow bridges or stops. The dynamic brake is housed in its own enclosure with its own ventilation fans to cool it.
The fans are controlled by an output relay which turns the fans on when the dehuller motor is running.
- 6.) The aspirator has its own variable frequency drive.
- 7.) Both drive's controls are attached to the main panel with remote docking ports. Ethernet cables carry the control signals back to each drive.
- 8.) The contactor for the agitator has a fuse block in front of it. There is also a capacitor in the main control panel to help start the agitator motor. The wire to the agitator has a plug that goes into an outlet on the main control panel so that the front cover of the dehuller can be removed.

All of the wires between the panels are run in liquid tight flexible metal conduit with an internal ground wire. The control wires need to be kept separated and run in separate conduits from the supply and power wires. The enclosures need to be NEMA 4 or 12.

The dehuller is designed to accept a 213TC or 215TC frame motor. Remember that the motors you use with the variable frequency drives have to be "Inverter Duty".

The frame of the machine may have to be adjusted to fit the panel size that you and your electrician decide to use.

Fabrication



I blued the back plate of the dehuller and used my height gage to accurately layout all of the hole locations.

I used an automatic center punch to get accurately located marks.



I deepened the marks with a handheld center punch and a hammer



I used my magnetic drill press with an annular cutter to drill holes over 1/2" in diameter. Under 1/2" in diameter I used traditional twist drills in a drill chuck on the magnetic drill.

Bolt the motor to the dehulling chamber plate to accurately locate the motor ring. Make sure that the motor shaft has adequate clearance all of the way around it.



Wrap the motor with foil to protect the paint from weld splatter. Just tack weld the ring in several locations then remove the motor before doing the actual welds.

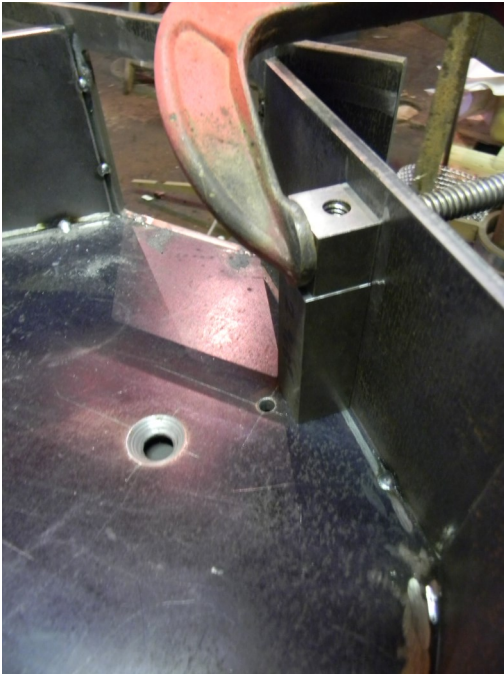


Use a piece of sheet metal to keep weld splatter off of the inside machined surface of the motor ring when welding.

I made a piece with a keyway and a bar welded onto it, so I could drill and tap the 3/8-16 threaded hole that holds the hammer holder in location.



I used a wood clamp to hold the metal where I wanted it while I tacked it in place.



I used a spacer to position the screen holder mount at the correct height. The clamp keeps it from shifting while being welded.

I used drilled and tapped spacers to locate the threaded studs in the front wear plate.

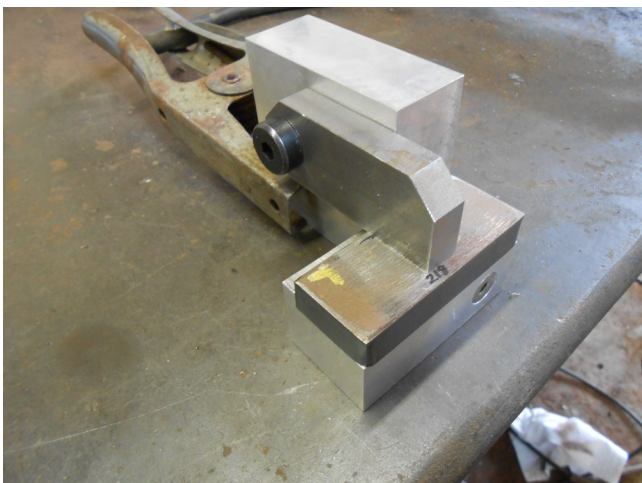


The dehusking chamber fit together. Make sure that the screen holder can be easily removed.

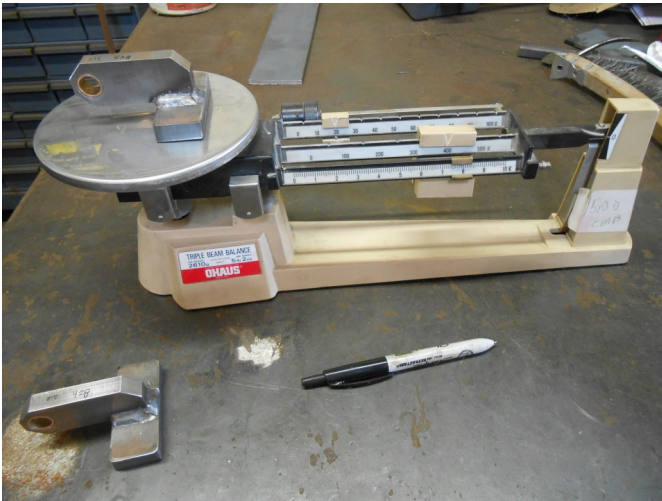


This is the trick to welding the sheet metal parts with minimal distortion. Place tack welds about every inch along seams. Weld 1" then skip down to another weld. Only come back to weld the next section once the first weld has cooled.

I broached the keyway for the hammer holder on my hydraulic press. Here I am practicing broaching with the piece I will use to hold the motor shaft while I drill and tap it.



I made this aluminum jig to locate the hammers a set distance from the pivot point. Make sure the weight of your hammers are the same before welding.



The hammer pieces weighed the same before welding and were welded exactly the same distance from the pivot because the jig was used. Then I used the over-all weight of the hammers to make matched sets of hammers. I matched the hammers within 1 gram of each other.

I stamped numbers into each hammer pair so that they can be kept straight.



Before sandblasting and painting, the machine was trial fitted together. I recommend using an automotive grade paint either 2 component epoxy or an enamel with a hardener for a long lasting quality finish.

Parts Not Listed in the Blue Prints:

1. Radial Blade Fan: Dayton 6YG63

I used a 56 frame 1hp inverter duty motor to run this fan.

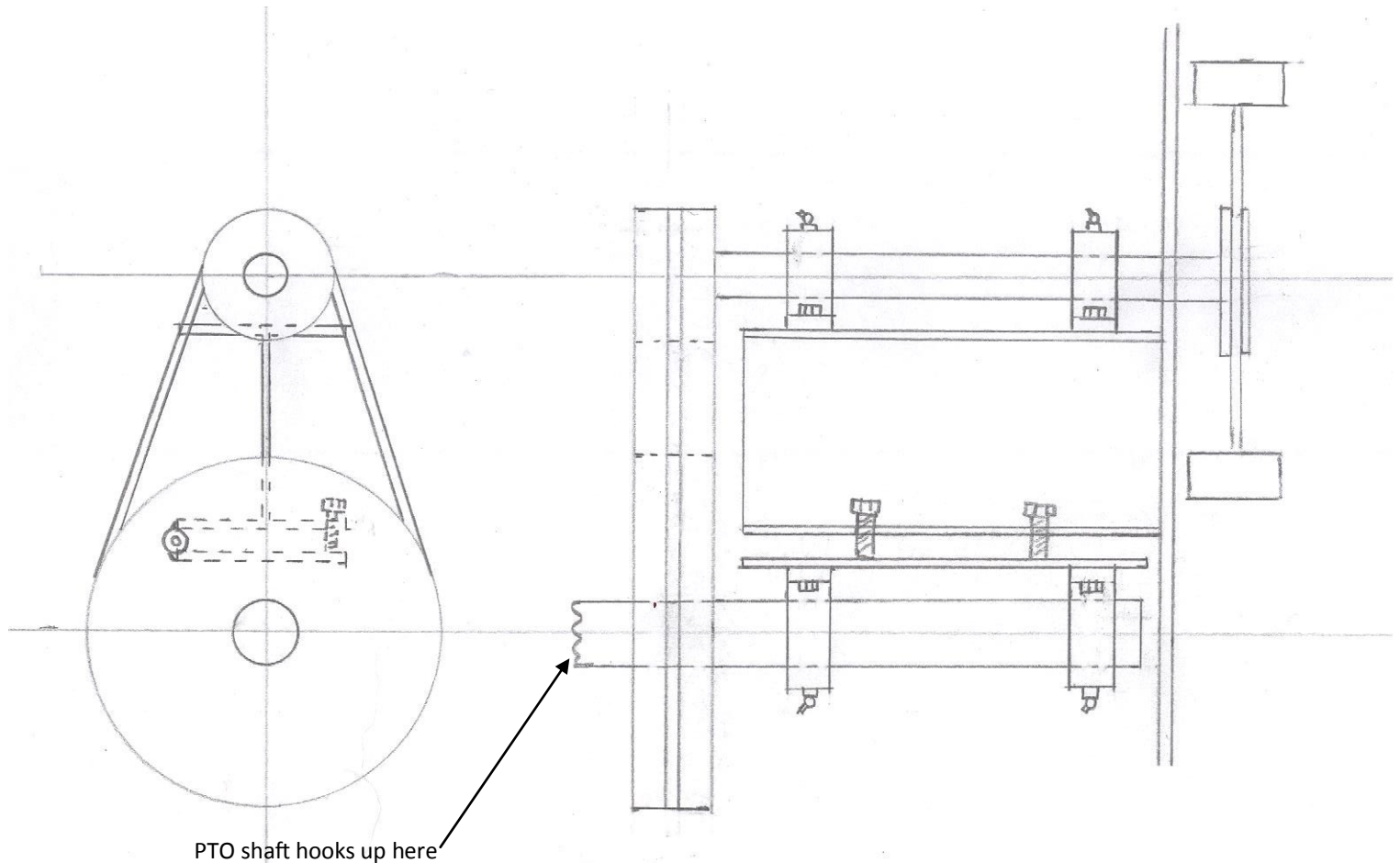
2. Agitator Motor : Bison 016-175-0096 17 rpm 1/20hp motor

3. Magnetic door magnet: MSC#: 00232256

I used a water cooled diamond brick saw to cut this to size

4. Magnetic door hinge: MSC#: 56568363

How this design could be adapted to operate off of a tractor's PTO:



The dehusker should be mounted on a trailer hooked to the tractor or adapted to fit the 3pt hitch of the tractor (this is so that if the dehusker plugs the torque from the PTO doesn't flip the dehusker over). The bearings for the jackshaft would be mounted on the top of a I-beam welded to the back of the dehusker plate. The hammer holder would be on the end of the shaft in the dehulling chamber. A 3" diameter pulley would be on the other end hammer holder shaft.

The lower PTO shaft bearing would be mounted on a plate hinged on the bottom of the I-beam. On the end of I-beam away from the dehulling chamber there would be a 8" pulley before where the PTO shaft hooks up. A 540 rpm PTO speed would give you a hammer shaft speed of 1,440 rpm.

PTO shafts and pulleys can be very dangerous so make sure that all necessary safety guards are incorporated into your design.

You should use a 2 or 3 sheave pulley to transfer power to the hammer holder shaft.

For the aspirator fan you could use a Nema 4 or Nema 12 enclosed Variable Frequency Drive. This drive could be setup to have normal 115v wall outlet power in and 3 phase power out to the drive motor.

If you don't want to use the variable frequency drive, you could use a single phase motor on the aspirator fan with a 4" dust collector gate valve to control suction of the aspirator. Please note that this would not be an efficient set-up as the tractor would need to run continuously.

I wish you the best of luck in building your own Spelt Dehuller. If you have questions feel free to contact me.

Regards,

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