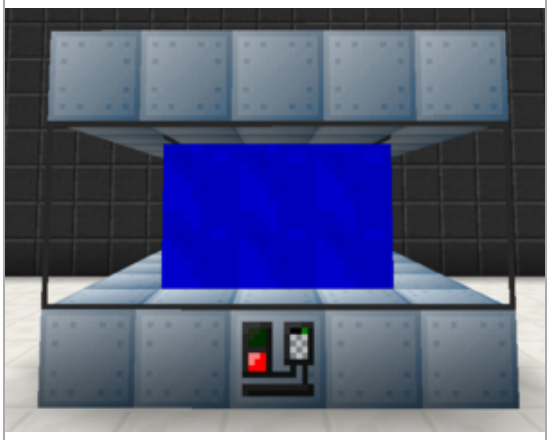
GT New Horizons

Bacterial Vat

The **Bacterial Vat** (BV) is a HV tier multiblock for fermenting fluids in large quantities. Bacteria contained within the vat break down organic compounds into something new, such as *Saccharomyces Escherichia* turning grape juice into wine. The species of bacteria, and therefore the recipe, is determined by placing a petri dish with a culture inside the controller block of the machine. All cultures are made in the Biolab singleblock machine. Some more exotic and alien species of bacteria require radiation to survive which is supplied through a radio hatch containing radioactive materials. The fermenting process itself is closely tied to the carrying capacity of the environment, meaning the output hatch should stay as close as possible to 50% capacity for maximum growth and productivity. Although the BV is mandatory for progression in UV, the player can later craft all the necessary fluids in the Quantum Force Transformer.

Bacterial Vat



Mod	GregTech
Relevant Quest	Bacterial Vat
Tier	HV
Size	5x5x4 (LxWxH)
Rotatable	Yes

Construction

The walls of the BV are entirely *tiered* glass which is only a minimum requirement for certain recipes and does NOT limit the tier of the energy hatch. Multi-amp and laser energy hatches are NOT accepted, but there is no restriction on the number of regular energy hatches or the number of imperfect overclocks. Only one output hatch and one radio hatch is allowed. Use the Multiblock Structure Hologram Projector to visualize/build the BV where the number of projectors held in a single stack determines the tier of the glass.

Requires:

- 1 Bacterial Vat (Controller)
- 19-45 Stainless Steel Machine Casing
- 32 Tiered Glass
- 1+ Energy Hatch
- 1 Maintenance Hatch
- 0-1 Radio Hatch
- 0+ Input Bus
- 1+ Input Hatch
- 0+ Output Bus

BVs can wallshare each of their sides to save on glass, casings, and hatches. That includes both the output hatch and the radio hatch which helps simplify automation setups and save on radioactive materials. If sharing between four machines, one hatch can go on top and the other can go on bottom. The only restriction is that the glass must all be the same tier for the BVs to properly form.

Growing Cultures

All BV recipes require a specific petri dish with a culture inside the controller block. Petri dishes are acquired from the **Biolab**, an HV+ singleblock machine for all biotechnology related recipes. The Biolab has five different operating modes which is determined by the module in the lower right-hand slot of its inventory. If no module is inserted, it will attempt to extract bacteria from any input ingredients and place them in a sterilized petri dish as a new culture. It is highly recommended to build multiple Biolabs inside a cleanroom to avoid constantly swapping out modules all the time.

Biolab Modules

The **DNA Extraction Module** (Ex) extracts the DNA of a bacterial culture from a petri dish and places it in a DNA sample flask. This process requires distilled water, ethanol cells, and detergent powder (extracted from vines) to break open the cell membranes. The probability of obtaining a valid DNA sample may vary.

The **PCR Thermocycling Module** (PCR) reads a DNA sample flask and stores the information digitally within a data orb. This process involves heating the DNA to separate the two strands of the double helix and then supplying polymerase enzymes to rebuild the missing halves out of fluorescent DNA. The digital sequence is then generated by shining a laser on the end of each strand which glows a specific color based on the nucleic acid. The probability of obtaining a valid data orb may vary.

The **Plasmid Synthesis Module** (PS) writes the gene data from a data orb onto a blank plasmid. Plasmids are small loops of DNA separate from a bacteria's main chromosome, often holding genes that the bacteria would not normally have. This process requires liquid DNA and enzyme solution to create the custom piece of DNA and insert it into the plasmid. A data orb for *Beta-Lactamase* is required in addition to the data orb with the DNA sample to boost the plasmid's resistance to certain antibiotics. The probability of obtaining a valid plasmid sample may vary.

The **Transformation Module** (Tr) inserts a plasmid sample into a bacterial culture to provide it with the custom gene. This process involves generating a rapid electromagnetic pulse to open small holes in each of the cell membranes, allowing the plasmid to enter. Cells that do not receive the plasmid lack any antibiotic resistance and are easily killed off by injecting penicillin. The result is a petri dish with a culture where all cells contain the same custom gene. The probability of obtaining a valid petri dish may vary.

Example Walkthrough

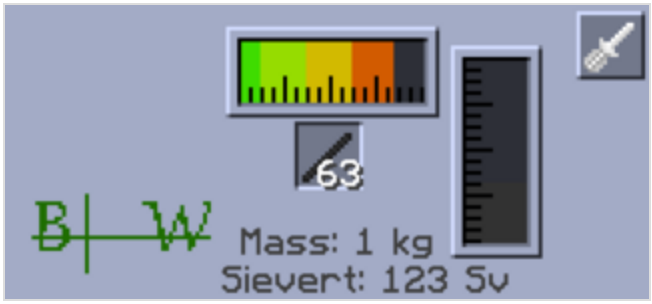
In case the player is not very familiar with modern biotechnology, this subsection walks through obtaining the *Xenoxene Xenoxsis* petri dish which is needed for producing xenoxene in the BV. Note that many Biolab recipes involving these modules have very low probabilities of success meaning this

Step	Machine (Module)	Instructions
1	Biolab (None)	Obtain a *Escherichia Cadaver* petri dish from water and rotten flesh.
2	Biolab (None)	Obtain a *TCetiEis Fucus Serratus* petri dish from unknown liquid and TCetiE seaweed.
3	Bacterial Vat	Produce tcetieisfucusserratusfluid from the *TCetiEis Fucus Serratus* petri dish.
4	Biolab (None)	Mass produce *TCetiEis Fucus Serratus* petri dishes from the tcetieisfucusserratusfluid.
5	Biolab (None)	Obtain a *Barnadafis Arboriatoris* petri dish from unknown liquid and BarnardaC Wood.
6	Bacterial Vat	Produce barnadafisarboriatorisfluid from the *Barnadafis Arboriatoris* petri dish.
7	Biolab (None)	Mass produce *Barnadafis Arboriatoris* petri dishes from the barnadafisarboriatorisfluid.
8	Biolab (Ex)	Extract a *Beta-Lactamase* DNA sample flask from the *Escherichia Cadaver* petri dish.
9	Biolab (Ex)	Extract several *Barnadafis Arboriatoris* DNA sample flasks from the *Barnadafis Arboriatoris* petri dish.
10	Biolab (PCR)	Generate a *Beta-Lactamase* data orb from a *Beta-Lactamase* DNA sample flask.
11	Biolab (PCR)	Generate a *Barnadafis Arboriatoris* data orb from a *Barnadafis Arboriatoris* DNA sample flask.
12	Biolab (PS)	Mass produce *Barnadafis Arboriatoris* plasmid sample flasks from the *Barnadafis Arboriatoris* data orb and *Beta-Lactamase* data orb.
13	Biolab (Tr)	Create *Xenoxene Xenoxsis* petri dishes from the *TCetiEis Fucus Serratus* petri dishes and the *Barnadafis Arboriatoris* plasmid sample flasks. Repeat as necessary for additional petri dishes.

Radio Hatch

A few exotic and alien species of bacteria require radiation to survive which is supplied through a radio hatch containing rods or long rods of radioactive materials. A radio hatch is similar to an input bus except it always consumes items even while the BV is idle. There are a few tiers of radio hatches with the only difference being their maximum capacity (kg). Optionally, a muffler upgrade can be installed by right-clicking the hatch to silence the absurdly loud and annoying sound that it makes.

The radioactive material inside the radio hatch determines the strength of the radiation in sieverts (sv), but the built in radiation shutter can reduce that as desired. There is no benefit to reducing the sieverts other than needing to have an exact amount for a specific recipe. Different materials also have different lifespans, but most are quite short. Therefore, it is recommended to only insert radioactive materials when the player intends to run the BV. The following table lists a few of the many radioactive materials along with their strength, lifespan, mass, and minimum radio hatch tier.



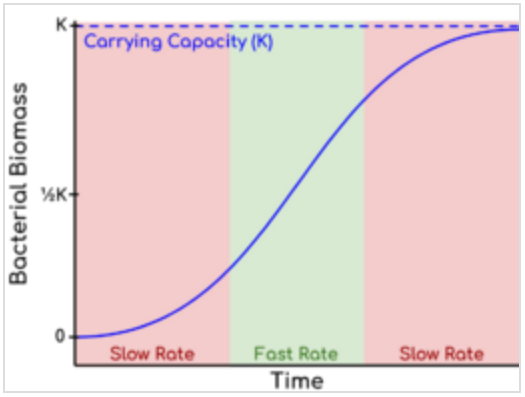
The Radio Hatch GUI. The radiation shutter is the button with the picture of a screwdriver.

Material	Strength	Lifespan	Weight	Min Hatch Tier
Bismuth Rod	83sv	198.00s	1kg	HV
Bismuth Long Rod	83sv	397.60s	2kg	EV
Thorium Rod	90sv	98.75s	1kg	HV
Thorium Long Rod	90sv	197.50s	2kg	EV
Uranium 235 Rod	92sv	80.85s	1kg	HV
Uranium 235 Long Rod	92sv	161.70s	2kg	EV
Uranium 238 Rod	92sv	80.85s	1kg	HV
Uranium 238 Long Rod	92sv	161.70s	2kg	EV
Plutonium 239 Rod	94sv	66.20s	1kg	HV
Plutonium 239 Long Rod	94sv	132.40s	2kg	EV
Plutonium 241 Rod	94sv	66.20s	1kg	HV
Plutonium 241 Long Rod	94sv	132.40s	2kg	EV
Americium Rod	95sv	59.90s	1kg	HV
Americium Long Rod	95sv	119.80s	2kg	EV
Tiberium Rod	123sv	17.80s	1kg	HV
Tiberium Long Rod	123sv	35.60s	2kg	EV
Naquadah Rod	130sv	14.40s	1kg	HV
Naquadah Long Rod	130sv	28.80s	2kg	EV
Enriched Naquadah Rod	140sv	10.65s	1kg	HV
Enriched Naquadah Long Rod	140sv	21.30s	2kg	EV
Naquadria Rod	150sv	7.85s	1kg	HV
Naquadria Long Rod	150sv	15.70s	2kg	EV

Output Hatch

The BV is a closed system with a limited carrying capacity (K) for bacteria to grow. All closed systems follow a sigmoidal population curve meaning the growth rate is initially slow due to a small starting population, increases in rate as the population grows, and then slows down again as the finite resources in the environment become a limiting factor. **Maximum growth in a closed system occurs at K/2**.

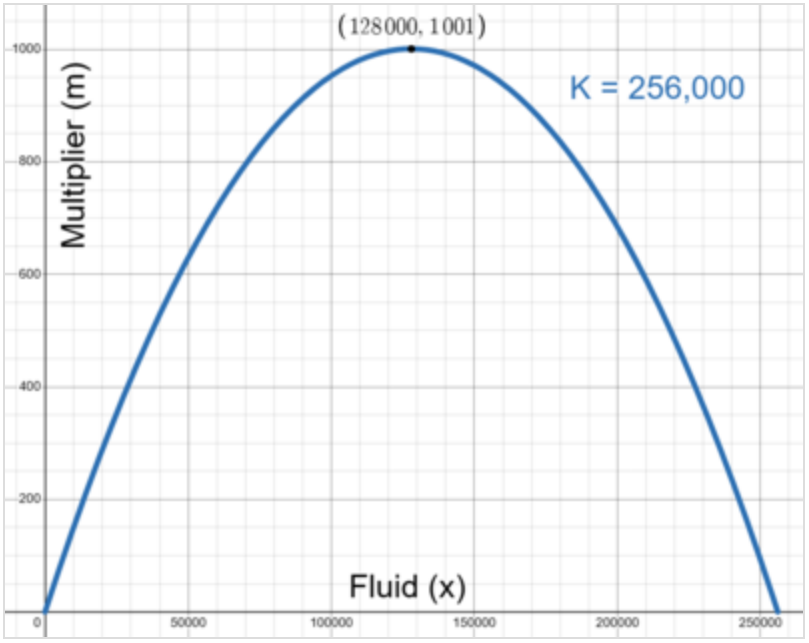
The size of the output hatch on the BV is equivalent to the carrying capacity (K) of the bacterial culture. Very little growth occurs when the output hatch is empty or when the output hatch is close to full. Ideally, the output hatch stays as close as possible to 50% capacity for maximum growth and productivity. More specifically, both the input AND output fluids are multiplied by up to x1,001 based on how close the output hatch is to K/2 or half-full. The solid ingredients and culture are not affected. The multiplier (m) is calculated using the following equation where K is the size of the output hatch and x is the amount of fluid inside.



A Sigmoidal Population Curve.

$$m = ceil\left(\frac{(\frac{-1}{K}(2x-K)^2+K)1000}{K}\right)+1$$

This equation is quadratic to reflect the derivative of the sigmoidal population curve. The ceiling operator, however, adds a small buffer around K/2 that rounds up values close to the maximum multiplier. This means the output hatch can just be close to 50% capacity to achieve the x1,001 gain. Larger output hatches have a larger buffer, but initially require more fluid to reach K/2. It is recommended to start with a very small output hatch and work up to larger sizes as the player gains more of the output fluid. The following table lists all the different output hatches and their thresholds for earning the maximum x1,001 multiplier (m). The graph is an example of a multiplier curve for the IV output hatch specifically.



Multiplier Curve for K = 256,000

Output Hatch (K)	Minimum	K/2	Maximum
ULV (8,000 L)	3,874 L	4,000 L	4,126 L
LV (16,000 L)	7,748 L	8,000 L	8,252 L
MV (32,000 L)	15,495 L	16,000 L	16,505 L
HV (64,000 L)	30,989 L	32,000 L	33,011 L
EV (128,000 L)	61,977 L	64,000 L	66,023 L
IV (256,000 L)	123,953 L	128,000 L	132,047 L
LuV (512,000 L)	247,905 L	256,000 L	264,095 L
ZPM (1,024,000 L)	495,810 L	512,000 L	528,190 L
UV (2,048,000 L)	991,619 L	1,024,000 L	1,056,381 L
UHV (4,096,000 L)	1,983,237 L	2,048,000 L	2,112,763 L
UEV (8,192,000 L)	3,966,474 L	4,096,000 L	4,225,526 L
UIV (16,384,000 L)	7,932,947 L	8,192,000 L	8,451,053 L
UMV (32,768,000 L)	15,865,893 L	16,384,000 L	16,902,107 L
UXV (65,536,000 L)	31,731,785 L	32,768,000 L	33,804,215 L
Giant (100,000,000 L)	48,418,862 L	50,000,000 L	51,581,138 L

Note that the multiplier (m) is calculated at the very start of a recipe. This is important if the BV is running continuously because the output from the previous recipe will factor into the calculation of the multiplier (m) for the next one. Ideally, the buffer should be greater than the amount of output fluid to still guarantee the maximum multiplier.

Automation

There are numerous methods to automate the BV, but only two are discussed in detail here because they are both relatively simple to setup and easy to implement within an AE2 network.

Method 1: GregTech

The core mechanic behind this approach is that the GregTech fluid regulator has an adjustable flow rate that can be easily disabled with a machine controller cover and fluid detector cover.

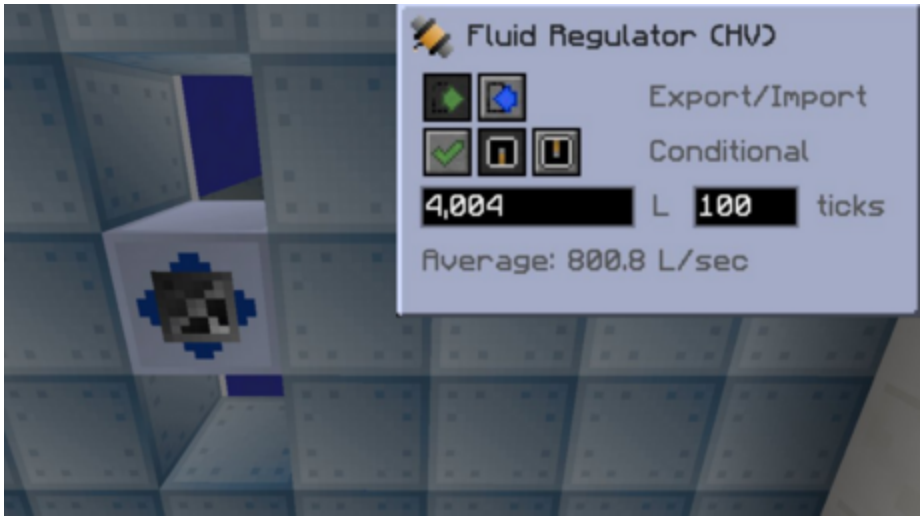
The following assumes that the player shares the same output hatch and radio hatch with four BV at once, but the steps are exactly same with only one or two BV. The last few steps can even be ignored

STEP 1

Place an IV+ output hatch at the bottom center casing of the four BVs. Place a fluid regulator on the bottom of the output hatch with the settings shown.

The 4,004L comes from the total combined fluid output of a single iteration and the 100 ticks comes from wanting to save TPS for a recipe that takes longer than 5 seconds.

An IV+ output hatch is necessary because that is the smallest hatch with a buffer wide enough for K/2 ± 4,004L to return the maximum x1,001 multiplier.

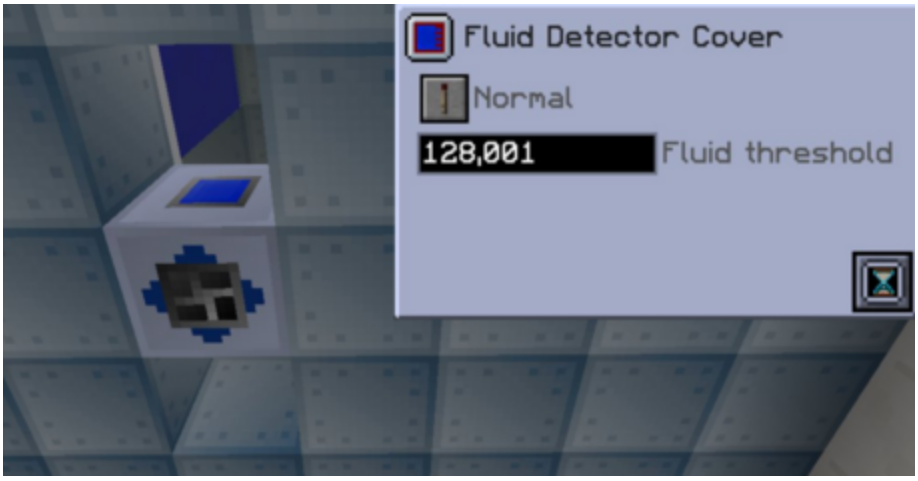


STEP 2

Place a fluid detector cover on one side of the output hatch with the settings shown. Also set the tick rate to 5 seconds.

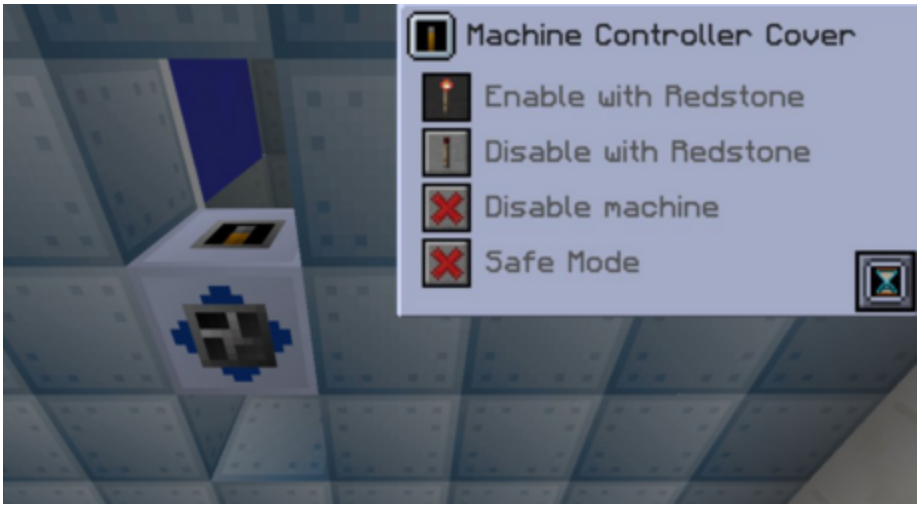
Set the cover to emit a STRONG redstone signal by right-clicking it with a soldering iron.

This will emit a redstone signal when the output hatch is greater than or equal to 128,001L or K/2 + 1.



Place a machine controller cover on the opposite side of the output hatch with the settings shown. Also set the tick rate to 5 seconds.

This will enable the fluid regulator when it receives a redstone signal from the fluid detector cover.

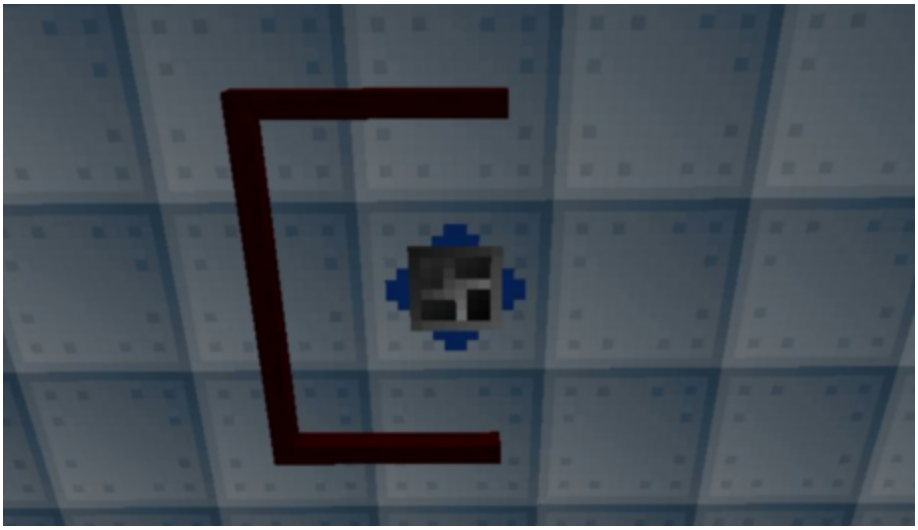


STEP 4

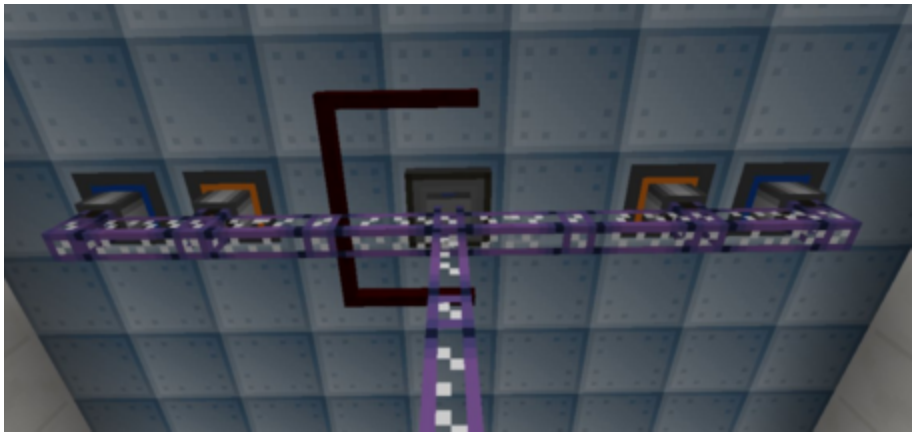
Place in the missing stainless steel machine casings for the BV's to properly form.

Trace some redstone alloy cable around the edges of the output hatch as shown in the figure. This will carry the signal from the fluid detector cover to the machine controller cover.

Wireless covers can also be used here, but it is not recommended because they are more complicated and take slightly longer to setup.



STEP 5

Place a dual interface underneath the output hatch to import any excess fluid. Also place ME stocking buses and ME stocking hatches, as necessary. The red alloy cable can occupy the same space as an AE2 cable (thin or dense). That's it! The only thing left to do is fill the output hatch to exactly K/2 or 50% capacity and enable the BVs.	

Method 2: OpenComputers

The core mechanic behind this approach is that an OpenComputers (OC) microcontroller can calculate the exact amount of fluid to extract from the output hatch and even move the fluid itself--all without any power or additional cabling. The only prerequisite is a working OC computer to flash the EEPROM with the necessary code.

STEP 1

In a running OC computer, create a new script by typing `edit bacvat5.lua`. The name of the script is not important. Copy the code on the right into the script. Use middle-click to paste.

Note that the siding values may be different (0=Down, 1=Up) depending on the setup. The sleep time may also need to be lowered depending on the recipe and number of overclocks.

Press CTRL+S to save and CTRL+W to exit. Use the same edit command to change the code at anytime.

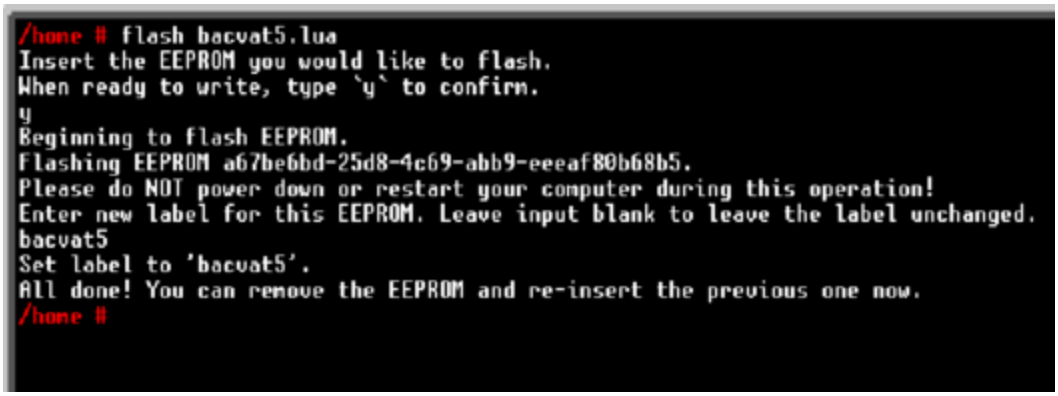
```lua
local t = component.proxy(component.list('transposer')())

while true do
    -- Extract Fluid (0=Down, 1=Up)
    local level = t.getTankLevel(1)
    local max = t.getTankCapacity(1)

    if level/max > 0.5 then
        t.transferFluid(1, 0, level - max / 2)
    end

    -- Sleep 5 Seconds
    computer.pullSignal(5)
end
```

STEP 2

Take the EEPROM (Lua BIOS) out of the same running OC computer and insert a new blank EEPROM.

Type `flash bacvat5.lua` to flash the script onto the EEPROM. Again, the label is not important.

Combine the flashed EEPROM with another blank EEPROM in a crafting grid to copy the code onto both of them. A flashed EEPROM is needed for every microcontroller or 1-4 BVs.

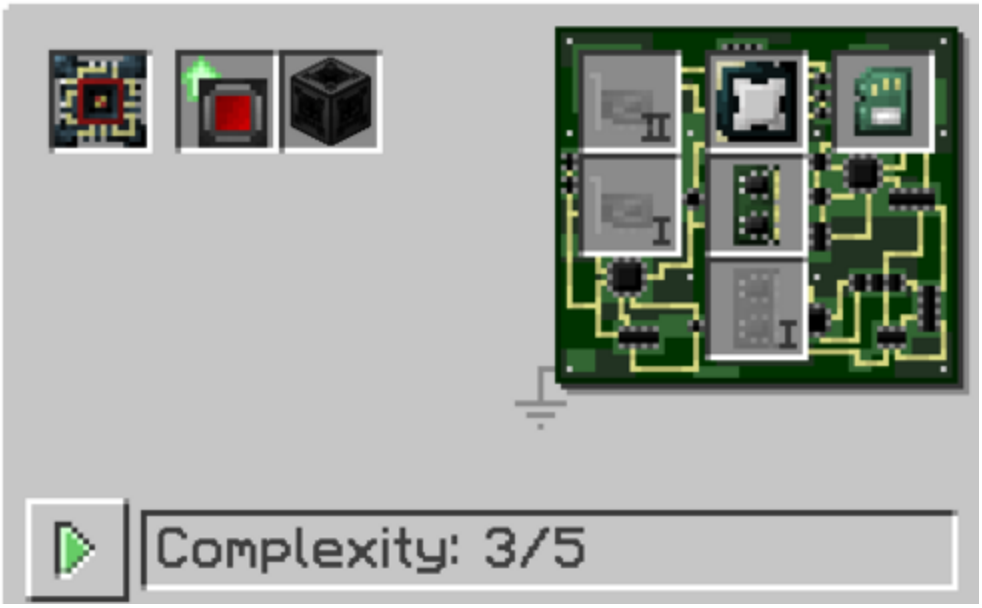


STEP 3

Build the Microcontroller in an OC Electronics Assembler. The bare minimum components:

- Microcontroller Case (Tier 2)
- Transposer
- RITEG Upgrade*
- Central Processing Unit (Tier 1)
- Memory (Tier 1)
- Flashed EEPROM

The RITEG upgrade is not absolutely necessary, but saves from having to run any sort of power cables (ie. quartz fiber) to the Microcontroller.

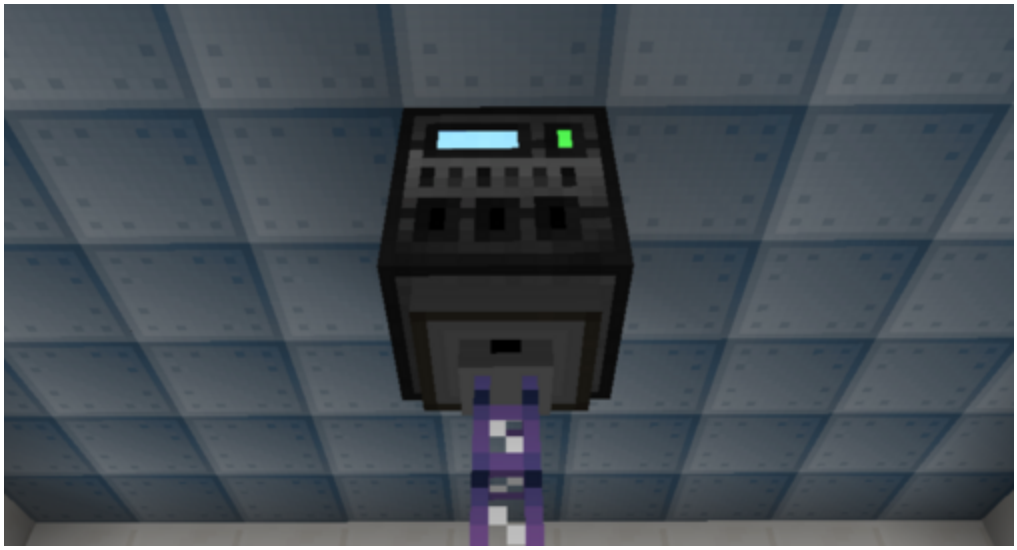


STEP 4

Place the Microcontroller underneath an IV+ output hatch and enable it with a right-click.

An IV+ output hatch is necessary because that is the smallest hatch with a buffer wide enough for K/2 ± 4,004L to return the maximum x1,001 multiplier.

Place an ME Dual Interface or large tank underneath the Microcontroller to import any excess fluid. Again, these sides are configurable in the EEPROM code. If necessary, disable the Microcontroller by shift right-clicking it.

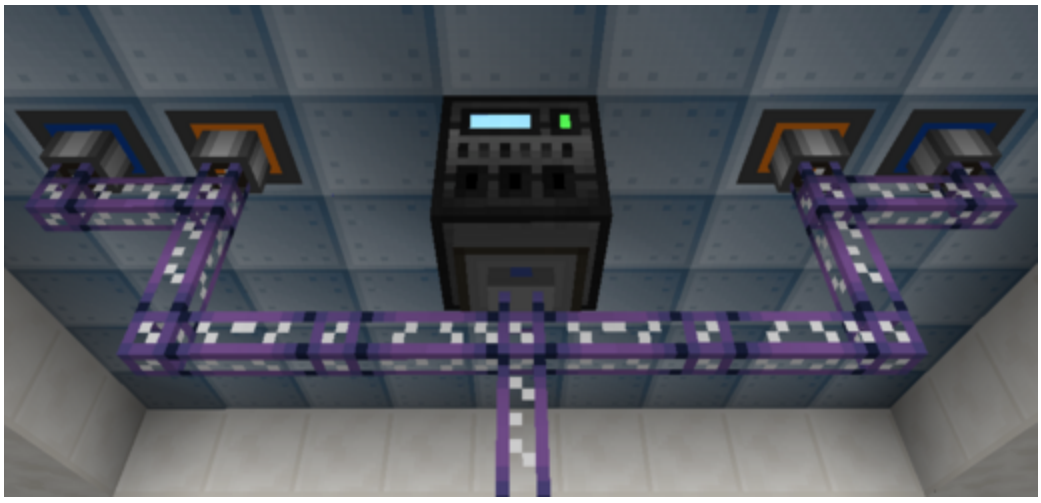


STEP 5

Place any ME stocking buses and ME stocking hatches, as necessary.

That's it! The only thing left to do is fill the output hatch to exactly K/2 or 50% capacity and enable the BVs.

Parallelizing this approach is as simple as building additional Microcontrollers.



Optional: Limit Radio Hatch (NIGHTLY ONLY)

Although not entirely necessary, the following steps are for automatically disabling the radio hatch to

STEP 1 (NIGHTLY ONLY)

Place a wireless activity detector cover on the bottom of EACH controller block with the settings shown. Also set the tick rate to 5 seconds.

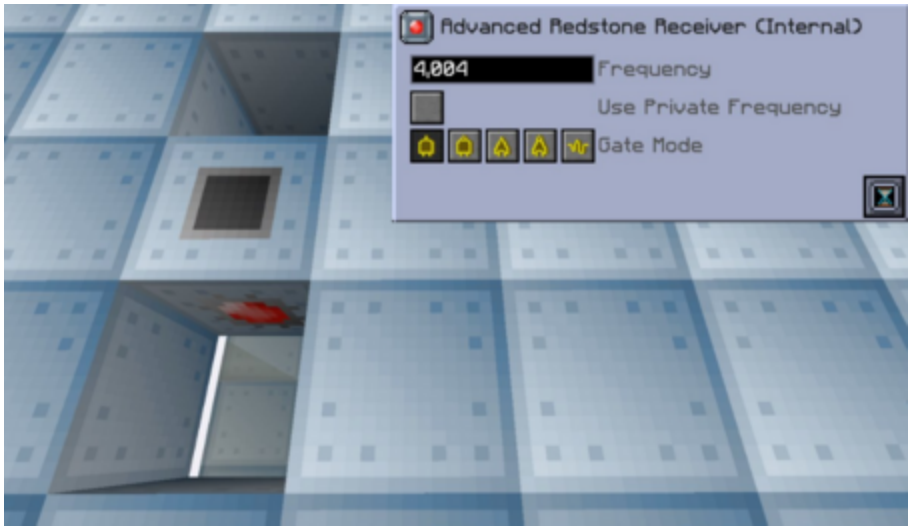
The frequency can be anything and it is recommended to use a private frequency in Multiplayer.

This will output a redstone signal to the 4,004 frequency when the machine is idle.

STEP 2 (NIGHTLY ONLY)

Place a radio hatch at the top center casing of the four BVs. Place an advanced redstone receiver (internal) on one side of the radio hatch with the settings shown. Also set the tick rate to 5 seconds.

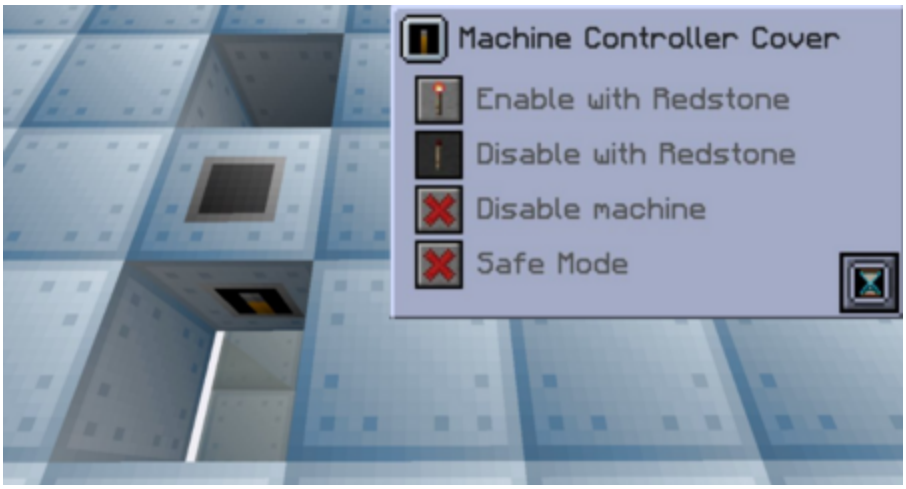
Internal means the cover will output a redstone signal to any other covers on the same block.



STEP 3 (NIGHTLY ONLY)

Place a machine controller cover on the opposite side of the radio hatch with the settings shown. Also set the tick rate to 5 seconds.

This will disable the radio hatch when it receives a redstone signal from the advanced redstone receiver (internal), or when all four BVs are idle



STEP 4 (NIGHTLY ONLY)	
Place in the missing stainless steel machine casings for the BV's to properly form. Provide the radioactive material to the radio hatch by any means necessary, such as an enderchest with a conveyor module.	
STEP 5 (NIGHTLY ONLY)	
Once all the BVs turn off from a lack of resources, it may be useful to create a "master switch" that turns them all on again. Place an advanced redstone transmitter (external) on any block that accepts covers with the settings shown. Also set the tick rate to 5 seconds. Activate the lever for a few seconds until at least one of the BVs are running, then flip it off again.	

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