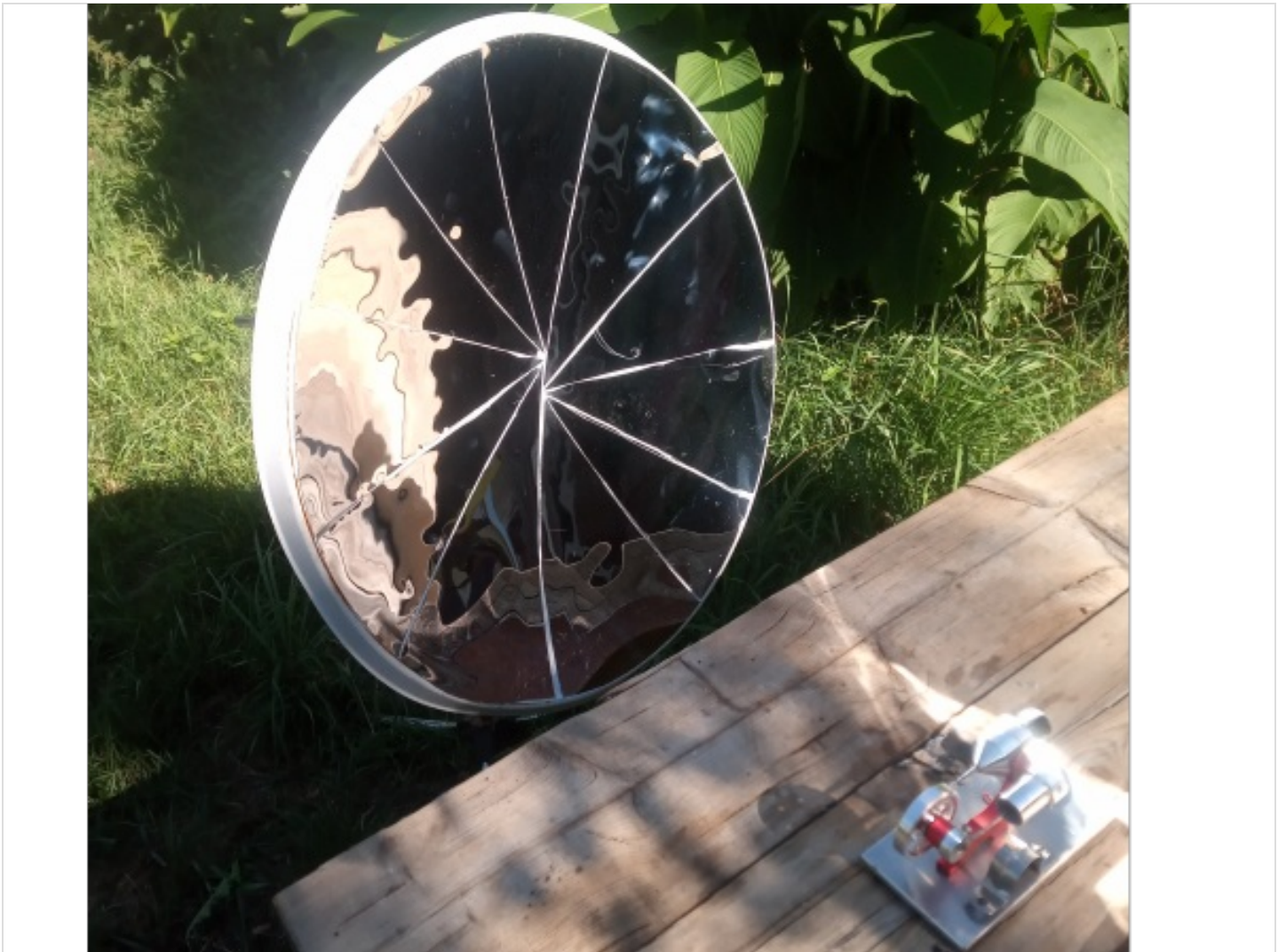



# Stirling Engine


 Aurelpere




[https://wiki.lowtechlab.org/wiki/Moteur\\_Stirling/en](https://wiki.lowtechlab.org/wiki/Moteur_Stirling/en)

Dernière modification le 01/08/2024

 Difficulty Hard

 Duration 1 day(s)

 Cost 50 EUR (€)

## Description

Things about stirling engines

# Summary

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# Introduction

We now live in a post-covid world, and whether you're part of those who think billionaires take very seriously climate change and want to address the question with population "regulation" and with survivalist bunkers, or whether you're part of those who think billionaires don't care and want just keep on getting richer and richer until the last drop of petrol, it becomes urgent to find alternatives to fascism and to the models we are offered, and it includes technical alternatives.

Stirling engine was invented in the XIX century, before combustion engine and there are a few "mainstream" industrial uses, in particular in the 60s-70s (Ford Torino, American ship Caloric).

Also called "hot air engine", its principle is to move hot air alternatively from 1 cold zone to 1 hot zone and gather the mechanical force produced by air dilatation (special dedication Bruno Lemair) and by air contraction.

Performant Stirling engines have necessitated a lot of research and development and have achieved yields more performant than combustion engines (around 40%).

They are reliable, silent, and have high yields.

They are however better adapted to regular regimes.

chronicle of a sleepless night before going handout leaflet against fascism in order to take advantage of the 24h after reception and before sabotage of the "toy" I have received.

## Step 1 - web literature review

We hereby list a few videos of diy stirling engine more or less diy and in french language

We can find engine made with a coca cola can (DDM Brico Voyageur <nowiki><https://www.youtube.com/watch?v=nBxKOKYx2rI>), wooden engine made with glass syringes for the pistons (Incroyables Experiences <https://www.youtube.com/watch?v=s79odgWz6BM>), a 125 cm<sup>3</sup> manufactured engine with an estimated power of 0,8kW to 8kW (0,6 horsepower to 6 horsepower) considered the measurement of 800 rpm and a tray mass estimated between 100g and 1kg (French Stirling Fablab [https://www.youtube.com/watch?v=Z24dZ3St\\_JE](https://www.youtube.com/watch?v=Z24dZ3St_JE) from series <https://www.youtube.com/playlist?list=PLE1TyIvCXNjylvWRI10LUsEMXKyRS6Ltx> on channel <https://www.youtube.com/@FrenchStirlingFablab>)

You can find notably resources to try to build

your own stirling engine that you won't find in the text below

As a bonus, for teachers, 1 example of a tractor and crane toys build in meccano here:

<http://cm1cm2.ceyreste.free.fr/stirling.html>

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_Stirling\\_moteur\\_air\\_chaud.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_Stirling_moteur_air_chaud.mp4) [https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_Moteur\\_thermique\\_fait\\_1](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_Moteur_thermique_fait_1)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_TUTO\\_INCROYABLE\\_MOTEUR\\_STIRLING\\_AMAZING\\_STIRLING\\_ENGINE\\_THE\\_LAST\\_EPISODE\\_S1\\_Ep7\\_.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_TUTO_INCROYABLE_MOTEUR_STIRLING_AMAZING_STIRLING_ENGINE_THE_LAST_EPISODE_S1_Ep7_.mp4)

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## Step 2 - Toy power

We will now try to measure the power of a Stirling engine called "scientific toys" that we can find on AliExpress or on resellers like science labs. You will find attached two videos showing 1 Stirling engine "scientific toy" that runs with heat source 1 flame coming from 1 candle and alcohol combustion. The engine comes with 1 small container and a wick that has to be filled with alcohol that produces 1 power adapted to the engine (video 1).

In video with the candle (video 2), the candle flame does not produce a power adapted and the engine only runs for a few seconds and then stops and becomes very capricious to restart (a bit aleatory after a few tries even after cooldown).

Therefore we measure the power of the two flames (video 3 and 4):

time to boil 10mL of water from 20°C to 100°C

energy = 10 \* 80 cal = 800 \* 4,184 J = 3347,2 J

time for alcohol lamp flame: 40s to 1min (whether simmering or boiling)

time for candle: 90 to 120s

"alcohol lamp:"

max\_power = 3347 / 40 = 84 W

min\_power = 3347 / 60 = 56 W

"candle"

max\_power = 3347 / 90 = 37 W

min\_power = 3347 / 120 = 28 W

To try to measure yields, we fix a mass to the motor (here a broken nut of 5g in video 5)

and we measure torque traction

and angular speed.

Broken nut mass is 5g and is fixed at a distance of  $d=3\text{cm}$  of the rotation axis.

Rotation speed measurement with a 25€ tachymeter this Tuesday 25 June 2024: the tachymeter works by friction (rubber traction that turns an axis of which rotation speed is measured): the traction happens after half a second to 1 second and displays values between 100 and 500 rpm and makes the engine stop.

Rotation speed measurement with 1 laser tachymeter (video 5): 1400 rpm with 5g broken nut attached at 3cm of axis

Rotation speed measurement with laser tachymeter for engine 2 (video 6): 1000 to 5000 rpm with 5g broken nut attached at 1,6 cm of the axis

The yield is low, but we must recall this is a toy and not an engine made for performance. We could however make the measurement exercise with a performant scientific toy (multi-cylinders, vertical mover, etc.). Philips Stirling engine can have yields up to 40%.

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_fonctionnement\\_lampe.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_fonctionnement_lampe.mp4) [https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_bougie.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_bougie.mp4)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_source\\_chaleur.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_source_chaleur.mp4)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_bouillir\\_bougie.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_bouillir_bougie.mp4)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_tachy2.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_tachy2.mp4)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_00023.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_00023.mp4)

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## Step 3 - Rotation speed verification with video analysis

To measure angular speed, we will use two softwares: 1 Python code sample based on OpenCV, and ffmpeg

Python commands:

```
sudo apt install virtualenv

virtualenv --python=/usr/bin/python3 .

source bin/activate

pip3 install opencv-python

import cv2

import os

def charger_images_video(video_filename, output_folder):

    """

    Loads video frames from a file and saves each frame as a JPG image.

    Args:

    video_filename: The path to the video file.

    output_folder: The folder where to save JPG images.

    Returns:

    A NumPy array containing the video images (3D array: frames, rows, cols).

    """

    # Open video with OpenCV

    cap = cv2.VideoCapture(video_filename)
```

```

#Check successful opening
if not cap.isOpened():
    print("Erreur d'ouverture du fichier vidéo:", video_filename)
    return None
# Check that the output folder exists, if not create it
if not os.path.exists(output_folder):
    os.makedirs(output_folder)
# Empty list to store video frames
images_list = []
frame_number = 0
# Play video frames frame by frame
while True:
    ret, frame = cap.read()
    # Check image playback
    if not ret:
        break
    # Save each frame as a JPG image
    frame_filename = os.path.join(output_folder, f'frame_{frame_number:04d}.jpg')
    cv2.imwrite(frame_filename, frame)
    # Add image to list
    images_list.append(frame)
    frame_number += 1
# Close video capture
cap.release()
return images_list
# Example of use
video_filename = '00009.MTS'
output_folder = 'frames'
images_list = charger_images_video(video_filename, output_folder)

```

commands ffmpeg:

```

sudo apt install ffmpeg

ffmpeg -i 00009.MTS -vf fps=25 output_frame_%04d.png

```

You can reproduc the measurment with the sourc video fil ([link here](#)) and the previous sampl code

Unfortunately at this stag of experienc, the 25fps video doesnt allow to measur correctly

the angular speed of the engine is too fast et makes blurred images on the video broken down in 25 images per second

Unfortunately the captation at 60fps or more is expensiv (sony camera or zcam at mor than 1000€ on amazon. the advantag is you hav 14 days to test the camera on get reimbursed if it doesnt fit)

w can find 60fps webcam but after a test (Svpro Full HD 1080P Webcam USB Objectif de Mise au Point Manuelle 4 mm, 30fps/60fps/100fps Caméras de Bureau USB CMOS OV2710 pour Linux Windows Android Mac OS, Plug and Play at 33€ on amazon) this wednesday 26 of june captures at 30fps. And you cant really configure video captation software adequately, see this page for exempl wher ther s no parameters to defin fps:

[https://wiki.archlinux.org/title/Webcam\\_setup](https://wiki.archlinux.org/title/Webcam_setup)

test with zcam e2:

video of 60s at 60fps (in theory 3600 frames) with a bit of therebentin (no more alcool 90° confiscated by the cops): the engine runs but visibly slower than when the container is full of 90° alcool. W verify rotation speed.

Strangely, i hav a messag "process stopped" at frame 273 with python script

and ffmpeg does the job and w obtain half a rotation between two consecutive frames, which means 30 rotations per second, which is indeed 1800 rpm

File availabl here if you want to verify:

<https://vpn.matangi.dev/stirling.mp4> (1,8Go)

## Step 4 - Run the engine with a solar source

Making a performant stirling engine requires a lot of research and development (go! for hackers who want to leak phillips archive of th ford torin - yes 60s and 70s is not only great for music-)

In theory, with a 40% yield, it requires a solar receptor of 2,5m<sup>2</sup> (approximately a receptor of 90cm radius) for a motor of 1kW

w will here scale based on the flam power that runs th engine correctly:

60W to 90W

W will first us 1 small reflector on which we will fix bits of broken mirrors (after a fixation test it is dramatically worse than with the initial surc of the reflector) and measur the tim it takes to hav a small quantity of water boil

and w will make a linear scaling for an adapted diameter (the power of the sun is linear of th sunny surfac)

test this sunny tuesday june 2024

6cm radius reflectors on the photo : the reflecting surface is made of "bumps" not necessarily as good as dedicated surfaces that can be bought for example at solar brother (<https://www.solarbrother.com/acheter/reflecteur-solaire-adhesif-s-reflect-500/>)

When putting the finger at the center of the reflector at noon and pointing at the sun, w hav a sensation near being burned with a lighter after 5s.

Th test for boiling 3mL of water failed, wether because the surface is not smooth enough, wether because th container makes too much shadow on the reflecotr, wether because the reflector is not well enough oriented to the sun or because the container is not well placed at the focal converging point of the sun rays

The sunlight is approximately 1000W/m<sup>2</sup>, and the surfac of the reflecotr around:  $3,14 * 0,06 * 0,06 = 0,0113m^2$

Th power of the reflector is therfor theoretically around:  $0,0113 * 1000 = 11,3W$

To get a power of 90W at noon (w can modulate to lower at another time or when the sunlight is lower), it would require a reflector of radius r:

$r = \sqrt{(90/3,14 * 1000)} = \sqrt{(90/3140)} = \sqrt{(0,02866242)} = 0,17m$

W would therefor need a piec of spher of around 34cm of diameter

Th satelite antenna (said parabolic) retrieved in a recycling shop is around 60cm diameter, which is way too larg, th surfac being linear to th squar of th radius (in first approximation)

W will therefor buy a parabolic antenna of 40cm diameter (not found lower) and fix a solar reflector tape

Test 12/07 : negative with 40cm parabolic antenna and adhesiv tap: th cylindr of th piston is transparent and the heat of th concentrated sun rays doesnt heaten up well the cylindr. W cant tak to pieces th egin to put steel whool inside lik in stag 1 video. Test tomorrow with tinfoil glued to the cylindr. Otherwis need to find an egin with metal cylindr

Video is bugged and not uploadabl, test again when digital weather is better

negative test of 13/07 noon with tinfoil on cylindr: finetuning the parabolic antenna on the cylindr is difficul, need to be very accurat and with th gear i hav (a mic leg) it requires to suspend the engine in the air, etc.

negativ test of the 16 of july 18h: parabolic antenna of 40cm, concentrated sunlight rays ok, insufficient solar power

negative test of 23 july 18h: parabolic antenna of 60cm, concentrated sunlight rays too scattered, insufficient solar power

the concentrated sunlight square is too scattered. It seems it would be appropriate to do a more accurate concentrator (a real sphere piece)

W will try after the holiday to do a spheric concentrator (so with a tinier focal point) with a plaster mould on a sphere like a yoga/kine baloon. If you want to do a tutorial for doing this typ of concentrator, feel free to do so!



[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_3mL\\_eau\\_reflecteur.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_3mL_eau_reflecteur.mp4)

[https://wiki.lowtechlab.org/wiki/Fichier:Moteur\\_Stirling\\_reflecteur1.mp4](https://wiki.lowtechlab.org/wiki/Fichier:Moteur_Stirling_reflecteur1.mp4)





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## Step 5 - Make and optimize a mobile solar receptor

It is her i pass you the ball

First, we need to think about a receptor that follows the sun dynamically during the day based on its position (the variables are date and time and latitude and longitude) and more importantly: that is able to gather and send sunlight rays concentrated to a fixed point at any time during the day

Then, we can imagine 1 thing based on several receptors of distinct diameters adapted to a varying sunlight

We then have an infinite source of renewable energy, transportable that will work for a sunlight with a high threshold and a low threshold

We can even imagine 1 society where machines don't run when the sunlight is not good enough, but this is science fiction

To give some landmarks, the biggest one-piece mirrors we are currently able to make are telescope mirrors of 30m diameter

Telescope mirrors of 5m to 10m are more common for big telescopes

I'm not a specialist, just a populariser concerned with climate change

and the rise of fascism

Therefore and at this time of my experiment, only two practical aspects are questioning me for an everyday use

to stop the engine (you don't only need to stop injection)

for longer use: keep the cold source cold enough and long enough without oversizing the power at hot source input (for a performance  $\Delta T$ )

And because at a time of looming fascism rising in many countries, we must stop auto-censorship to talk politics when speaking in our own name

1 government that would take seriously climate change would have long ago put

Stirling engine at exams, encouraged consortiums to work on that,

and created mixed groups of engineers, technicians, DIY workers without diplomas from different territories to work on this type of questions!

Scientific knowledge is contextual of epoch and this is not only in spatial engineering (going on the moon)

we have lost knowledge. If lobbies prevent from putting again at the agenda forgotten techniques,

that are reliable, it's a political role to create necessary incentives!

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## Step 6 - Your turn

her w are, you hav now web resources to mak your own stirling engin, leads to do research on performant engin builders, a methodology to test and verify rotation speed lower than 3600 rpm in context of digital surveillance and shackle, and ideas for concentrator engin based on dynamic concentrators

For an sun following algorithm, you can hav a look at the cod her:  
Dimensionner et faire un tracker solaire photovoltaïque low tech

However, a dispositiv based on 4 photoelectric cells and a small maximum seeking electronic circuit driving motors could replace a hard coded algorithm honourably and adapt to all latitudes and longitude without tweaking

I also hav a problem with sabotaged concentrators (scratches, reflector tape taken off) quite quickly, but im sur you will find ways of avoiding that too!

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