What engine for my glider???

Introduction
In this article, a personal experience on using various glider engine types is shared. Before I start, I have to do the usual disclaimer. The opinion in this article is mine and if it is shared with others, even better. The information presented here is subjective and the main goal is to share my experiences with fellow pilots. So dear reader, if you have any questions or comments, please do contact me as I would like to hear them.

Jet
For many of pilots, (yours truly included) flying a jet powered airplane is the ultimate dream. Finally during the July/August 2010 I had many chances to fly a jet powered glider. Actually many more than I hoped for, thanks to the rather optimistic task setter in Szeged. 😊 Anyway, back to the story... So, the dream came through. Although, jet in my dreams was substantially more powerful. And no kick-ass afterburner either.... Oh, well...

The Glider
HpH 304S (a.k.a. Shark) is a development of a Glasflugel 304 sailplane. That being said, it is so much improved that it can be seen as a brand new plane. One thing about Shark that is evident from the moment you see it, is that it is built incredibly solid, from the overall dimensions to impeccable finishes. It is also a BIG plane. Without going into too much advertising, it is a good plane and it can keep up with the best sailplanes in moderate conditions (from 1m/s to 2m/s average lift – totally subjective estimate by the author).

The Engine
The jet engine used in Shark is TJ42 with a maximal thrust 420N at sea level. The jet itself is relatively small, slightly bigger than a 2Lt coke bottle. Consumption on ~85% power is ~ 45 Lt per hour and at maximum in excess of 60 Lt per hour. Eish... It uses JET A1 fuel with 4% addition of special Shell turbine oil. The refilling of the 33 Lt fuel tank is manual and rather simple.
**Operation and Instrumentation**

The jet is operated by “throttle” which is really similar to a volume control, as it is just an electric control. In addition, the purpose built engine control and monitoring instrument is also equipped with two switches, namely “Extend” and “Start”. The whole system gets powered by flicking a “Jet Master” switch placed on the right console, next to the undercarriage lever. The control and management system is quite complex and I have been told that there is a full backup and redundancy as there are two computers checking each other and performing engine management. It is also important to note, that unlike most piston engine powered gliders, there is no direct control over extension and starting of the engine. That is done for a few reasons, mainly to prevent damage that can be done by an incorrect pilot’s command. I was eternally grateful for such an arrangement, as I heard horror stories about jets going “Boom”, if the engine management is not right. That being said, I think that they mainly referred to early WW2 jet fighters, but you never know....

Once the monitoring instrument, with an easy to read LCD screen, comes alive, in order to extend the engine, you need to set “Extend” switch to “On”. This extends the engine and the whole process lasts 2-3 seconds. It is important to note that at this stage, the extra drag from the jet engine is roughly equal to extended undercarriage. In other words, you can have the system ready and try for that last chance thermal.

The next step is to switch “Start”. This will basically indicate to the engine management system that you want to start the jet. And it will start, but it does that at its own pace and while being carefully controlled by the computer. If you try to open “throttle” sooner than it is ready, nothing will happen and the instrument will indicate “Set to Idle”. Realistically, it takes 4-5 seconds before you can apply full power. In total, 6-8 seconds from start to full power is very good in comparison with normal piston engines.

Once the power is on, you can feel a slight vibration that is very different from a piston engine. The level of noise is quite acceptable and you don’t need headphones.

The jet is optimised for a speed of ~150km/h and that is its most economical mode of operation. It is very important to note that you shouldn’t expect any decent climb rate. At maximum power, in real life, it will climb just over 1m/s, but you cannot afford to fly it at maximum power due to the power consumption, unless in an emergency. The way to fly the jet is basically level at between 140-150 km/h at 85% power. This will give you a slight climb (0.2 – 0.3 m/s ?) but more importantly, it will get you home. Now, if you start at low level (and I have started it as low as 80m AGL) it makes for an interesting flight home. At least for the first 10 minutes or so... Perfect for the Free State! Not so sure about the terrain around Gariep Dam though....

Once you finished with the jet, it is rather simple; you can basically switch off “Start” followed immediately with switching off “Extend”. There is no danger of retracting the hot jet (it reaches 700 C) into fuselage, as again, computers take over, run the engine a few times to cool down and retract it only when the engine is cool enough. This can take up to 2-3 minutes.

**Summary**

Pros:

- It is REALLY cool.
• Small drag penalty with extended engine
• Simple user friendly (and fool proof) operation
• Less mechanical complexity than piston engine
• It is REALLY, REALLY cool.

Cons:

• Bad rate of climb
• High fuel consumption, resulting in relatively short range (~150 km)
• No self launch capability
**Electric Engine**
During the worlds in Szeged, I also had a chance to fly an electric powered glider, namely LAK 17B FES with the Front Electric Sustainer (FES) system that was developed by the LAK representative in Slovenia, namely Znidarsic father and son team (Matija and Luka Znidarsic). So, here we go...

**The Glider**
LAK 17B FES comes from a Lithuanian factory, namely LAK, currently operating under name UAB / JSC "Sportine aviacija ir Ko", that has a history of producing solid and competitive gliders since early seventies. LAK 17B is their latest offering, based on the already successful LAK 17A, but with lots of improvement, including a new and improved airfoil, better comfort and AUW of 600kg. Preliminary testing puts it at least equal to the best in 18m class and it should be very competitive. That being said it is still too early to claim that with any degree of certainty, as it is not a mount of choice for the world best pilots who can afford German gliders or JS-1.

**The Engine**
The engine used in LAK 17B FES is a brushless direct current electric engine. It provides 15 kW continuous power at 100V and up to 25 kW for short time (= emergency). The weight of the engine is only 6 kg and the whole system, including batteries, is around 35 kg. The full charging cycle for batteries is less than 4 hours. The batteries can provide up to 3.6 kWh, which translates in close to an hour maintain the level altitude or up to 1200m climb. The propeller is of foldable type and it is a part of nose cone installation that houses the engine as well. Electric propeller brake is used to stop the propeller at desired position. Batteries are stored in fuselage behind the wings. The FES designer claims that there is virtually no drag penalty. This has been confirmed by another aerodynamic expert who linked the drag to that of bug wipers, in other words, close to nothing. It is important to note that FES can be retrofitted to a number of gliders and JS-1 has been considered.
**Operation and Instrumentation**

Now, the best part of the FES is the ease of operation. At this stage it is important to note that “instrumentation” consisted of one Amp-Volt meter, one variable resistance control knob and a switch. Doesn’t sound much, but it does the job! However, it has been confirmed that LXNAV is busy developing a custom built 57mm instrument that will provide all information related to FES and that will be used to control the operation of the engine.

To start the engine, it is enough to flick the switch and turn the control knob (a.k.a throttle). And that is it! The power is virtually a second away. The propeller starts turning and off you go. As the system is as simple and reliable as it can be, it can be sagely started at 10-20m. Climb is relatively good, I have tried it up to 2.2 m/s at full power and at 40 Amps (* 100 V = 4kW) the glider slightly climbs (0.3-0.5 m/s). At 4kW, one can basically fly for an hour.

The noise and vibration is really minimal and yet the noise is registered with most IGC approved loggers.

To stop the engine, it is necessary to quickly turn the “throttle” to minimum. This results in electric braking and the propeller folds back. It doesn’t stop always at the right angle, so I had to repeat the procedure. The golden rule is that, if you don’t see the prop, it has stopped at the right position. That being said, the author needs to elaborate that the propeller positioning (i.e. on the side of the front fuselage) is the only shortcoming of this system, due to the fact that visually it spoils the elegance of a clean glider.

**Pros:**

- No drag penalty
- Low weight of the complete system
- The simplest operation imaginable
- Simple mechanism, drastically reducing a chance of mechanical failure
- As the battery technology evolves, it will be possible to get even better performance through battery retrofit
- Relatively good performance
- Green solution

**Cons:**

- Aesthetics.
- Relatively short range (~150 km)
- No self launch capability
Conclusion

I have done a subjective rating, as summarised in the table below. The best rating is 1 and the worst is 3. I have tried to stick to quantitative criteria, as qualitative are even more prone to subjectivity. Please note that as a piston powered engine, a generic pylon type arrangement with its complex electronics and extraction/retraction mechanism was considered.

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<thead>
<tr>
<th></th>
<th>JET</th>
<th>FES</th>
<th>PISTON</th>
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<tbody>
<tr>
<td>Weight of the whole system</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Ease of operation</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Reliability</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Range</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Drag (when ready for operation)</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Climb performance</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Operating cost</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL RATING (less is better)</td>
<td>16</td>
<td>9</td>
<td>16</td>
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From the above table, it is evident that the electric system is a clear winner, but... The author had a chance to order an electric glider, yet he opted for a classical SOLO engine powered glider (same type). Why? Because I just couldn’t face the fact that my new glider would look like a catfish. In addition, the self launching ability and the performance (range, climb) of a piston engine were also important factors.

That being said, if you are looking for a sustainer and you can live with a foldable propeller in the nose, I would strongly suggest that you look at the FES system. It is not only the simplest and most reliable, it also offers an upgrade path through replacement of batteries as the technology improves.

And if you are still in touch with your inner Buck Rogers, the choice is obvious....

References

www.front-electric-sustainer.com

www.lak.lt

www.hph.cz