A Physics Project: Nuclear Fusion

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1 Purpose?

I intend to build a nuclear fusor for this final project, or if time and resources do not permit, at the very least, gain the necessary requisites to build such a thing (research and knowledge-wise). Nuclear fusion is easily attainable on the desktop scale with a small sum of money, and in this case, the only design capable of this would be a Hirch-Meeks or similarly-designed fusor. What's a fusor, you ask?

2 What?

A fusor is essentially a plasma globe with some fancy additions. The middle terminal is designed as a wire grid, so as to be large, hollow, and present the least amount of cross section to the plasma. A gas atmosphere at about 100microns or less is used, typically composed of deuterium in real fusion processes, but any gas (including residual air) will work to demonstrate the applicability of the project, as plasma will form no matter what. A large negative potential is applied to the terminal, on the order of 20-50kV, below 100mA. The end result is an ionizing plasma at the center of the globe, with ions ideally colliding into each other at the center of the terminal, due to electrostatic acceleration.

If you use deuterium gas, the ions will be smashing together at the middle– this process is hot enough to induce fusion.

3 But... that doesn't fit into the project categories!

That's ok. Currently, I'm considering doing it as a research project, since it seems that a large amount of knowledge will be attained anyway (even by this stage, I've read through tens of hundreds of pages). That way, if the funds and materials for the construction of a real demo fusor never show up, I still have something to show for my efforts. Moreover, this can turn into a long term project, with the final result culminating in a neutron-producing high-output fusor that actually does real deuterium-deuterium fusion.

Otherwise, I can surely enter this into the other two categories. As an experiment, I would be bound to real construction, which poses issues. The timeline would also have to be advanced substantially in order to allow time for experimentation, not just construction. Most likely, if attemnting to tackle this project as an experiment, the following question will be my guide: "Is it possible to attan nuclear fusion on a shoestring? (Or, how low of a voltage is required for neutron production?)"

For a Rube Goldberg project, the fusor can be implemented as a centerpiece. Say, if there's some wild contraption that activates the vacuum pump, backfills the vacuum chamber with deuterium, and switches on a voltage supply, it's set. I can set coffee next to it and heat it by the light of a mini-star. Neat, yeah?

4 This is dangerous though!

Not necessarily. The dangers of this project are well-understood and can be easily controlled. The two most poignant issues with this project are the matters of high voltage and high vacuum. With high voltage, a wrong step/connection could easily be my last, and circuitry needs to be built to a very stringent standard as to minimize corona losses/arcing/parts blowing out. Moreover, the hardware used in such a circuit is far from normal; typical acquisitions will most likely be made at electronics surplus stores (there's several in the area), hamfests, or (quite expensively) from major electronics retailers online. At the lowest operating capacity, the power supply is no more dangerous than that of a neon sign, and at the highest capacity (50-100kV) there are several other issues that would need to be dealt with before the dangers of the high voltage system would even come into play (neutron production mandates shielding to prevent from radiation). Also, the amount of current isn't horribly high–20-60 milliamps. While this combination of voltage and amps is lethal, it's nothing out of the ordinary.

As for the vacuum system, dangers with the vacuum chamber are most likely. Incorrect usage of a bell jar or polycarbonate container can lead to shattering and implosion at the high vacuum (1 micron) that's needed, sending high-speed shrapnel across the room and into innocent bystanders. This can be mostly negated by a polycarbonate blast shield, or a fine wire mesh (preferrably the former). Another thing of interesting consequence is the use of deuterium gas, which is flammable when in contact with air. If kept and used correctly, the gas is nearly harmless–it would only be introduced into evacuated containers and lines as to avert this risk.

The hydrogen isotope that's being dealt with, ^2H, is readily available in welding shops; it's used everyday in their work. It poses no radiation or special handling risks other than the general treatment of highly compressed gasses (which is to say, regulators, stainless steel lines, flow meters, and all the other requisites are normal).

5 But it's nuclear! Fusion!

Nuclear fusion of this sort has never hit break-even, so there's hardly any danger of me setting off an uncontrollable reaction. If I manage to get past the break-even point, where the temperature created by the reaction results in a self-sustaining process, I'll have to worry more about the press and companies running after me with dollar bills and cameras.

6 What else is needed?

Currently, I'm hoping to find sponsors for this project. This is a once-in-a-lifetime experience, and the parts involved can be highly costly if used. Perhaps, Poly can lend me some equipment. Vacuum pumps and tubing, bell jars, and other items are just a few of the parts that I know Poly already has. I would not mind paying a nominal fee in order to lease it.

Also, Poly has a great wealth of people here who can probably advise and help me. How about you, Mr. White? Would you be willing to guide me on the ins-and-outs of high vacuum/high voltage systems?

7 Is this really possible?

Oh, yes, it's been done before. Brian McDermott, currently a senior at a high school in Sudbury, Massachusetts, has accomplished fusion (with neutron byproducts) in his own time and spare money; the total setup takes up nothing more than a utility cart. There have been several institutions looking into this type of fusion, as well as several other independent researchers who have built fusors in their homes. Overall, however, while experience in this field is pretty varied and generally good, there is a small number of people interested, underneath 1000, most likely under 100, across the world.

These people have a website dedicated to their cause, http://www.fusor.net, as well as an online-forum. The tight-knit community makes it easy to find help with issues and definitely aids research–with a hobby like this, everybody's in it together. It's not nealy as common as sock puppets.

8 The Department of Energy's going to come after you.

The DoE has no problem with these fusors; there are tales of them frowning about transport across state lines, but other than that, there's no issue.

9 You're insane.

Not yet. Wait for next year.

10 Pictures of working setups

Attached are various pictures and prototypes of working, built fusors. Most of these were constructed underneath $5000, in some cases approaching less than $200.