Gas Cooled Fast Reactor (GFR)

Summary / Objectives:

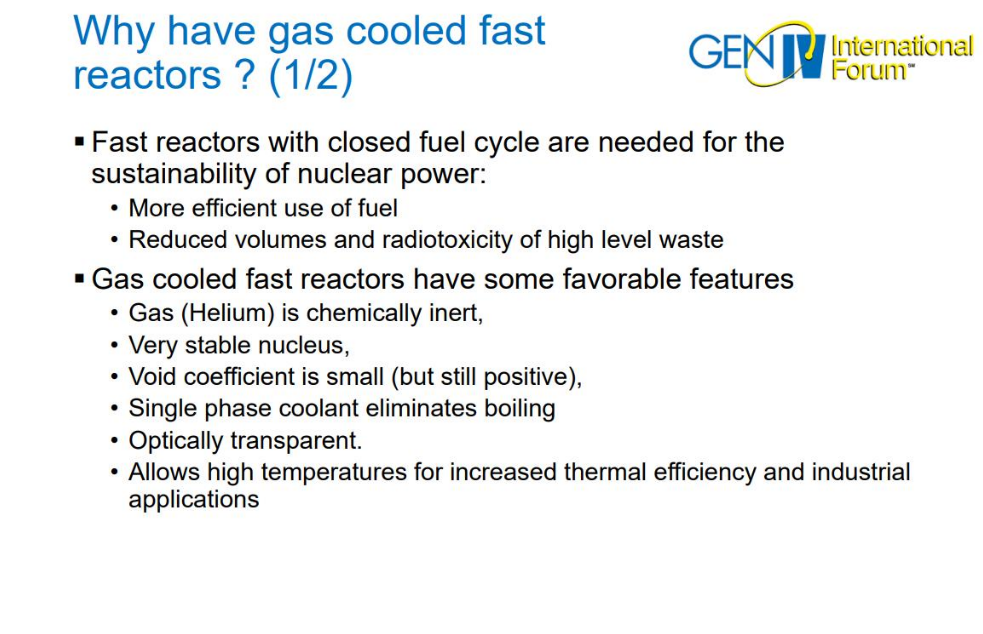
The Gas Cooled Fast Reactor (GFR) is one of the six promising technologies selected by the GIF. The presentation summarizes the main advantages and drawbacks of GFRs and the key design and safety issues as well as the related research and development programs.

Meet the Presenter:

Dr. Alfredo Vasile earned a Master of Physics Degree at the Balseiro Institut (CNEA, Argentine) and his Doctorate in Nuclear Engineering at the Grenoble University (France) in 1977. He joined CEA in 1981 working at the RAPSODIE sodium cooled experimental fast reactor at Cadarache. He has held laboratory head positions on core physics and safety studies both for light water reactors and fast reactors. Dr. Vasile participated at the Gen IV Roadmap definition process as a member of the Light Water Reactors Technical Group and was the French representative of the INPRO Steering Technical Committee for the Joint Study on Closed Nuclear Fuel Cycle with Fast Reactors. He is presently project manager of the ESNII Plus European Project on fast reactors, the French representative at the IAEA Technical Working Group on Fast Reactors, GIF GFR Steering Committee, GIF GFR Conceptual Design and Safety and GIF SFR Safety and Operation Project Management Boards. Dr. Vasile also serves as the CEA representative for the ALLEGRO GFR experimental reactor project.

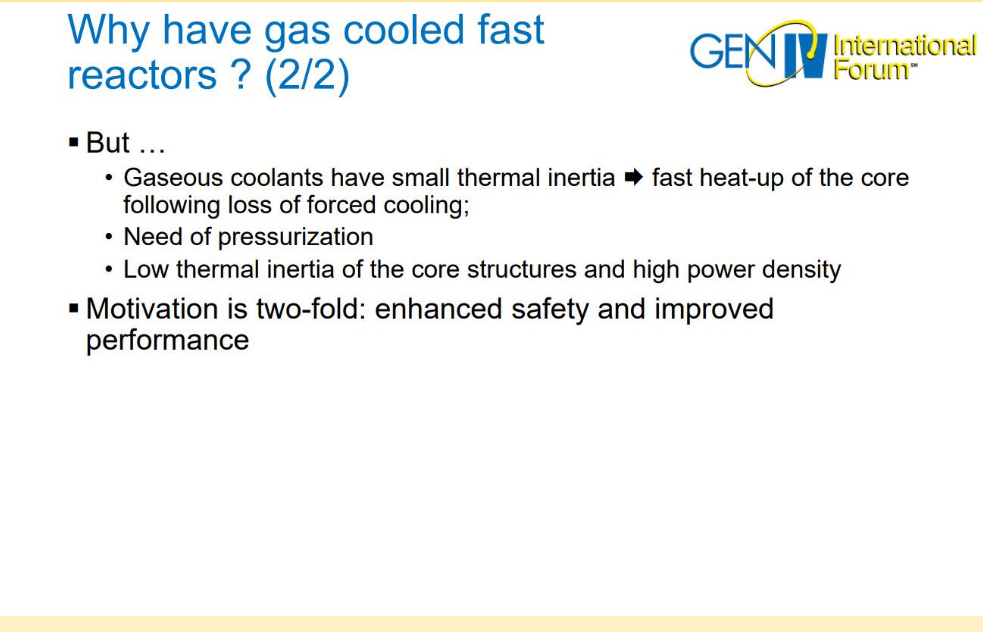
1. Motivations of fast reactor and GFR:

Fast reactor with closed fuel cycle can use nuclear fuels more efficiently, and reduce volumes and radiotoxicity of high level waste. GFR has some favorable features compared to fast reactors using liquid coolant.



2. Drawbacks of GFR:

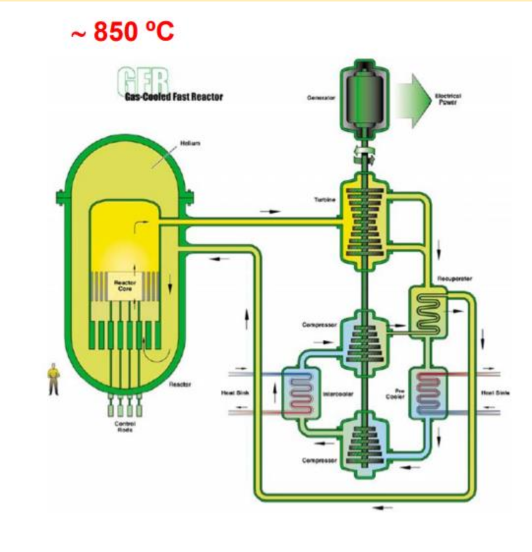
Typically gaseous coolant has a low thermal inertia, which leads fast heat-up of the core following loss of forced cooling. We need to have pressurized systems even in a normal operation roughly in range of 7 MPa. Low thermal inertia of the core makes the decay heat removal difficult.



3. The Gen IV GFR system:

The Gen IV GFR uses uranium-plutonium carbide with SiC cladding.

The core outlet temperature is 850 degree Celsius, which is very interesting characteristic for high efficiency and other applications of heat. The average power density is 100 MWth/cm^3, which is about 10 times higher than typical HTR, but lower than that of sodium cooled fast reactor.



Reactor Parameters	Reference Value
Reactor power	600 MWth
Net plant efficiency (direct cycle helium)	48%
Coolant inlet/outlet temperature and pressure	490°C/850°C at 90 bar
Average power density	100 MWth/m3
Reference fuel compound	UPuC/SiC (70/30%) with about 20% Pu content
Volume fraction, Fuel/Gas/SiC	50/40/10%
Conversion ratio	Self-sufficient
Burnup, Damage	5% FIMA; 60 dpa

4. Present project ALLEGRO:

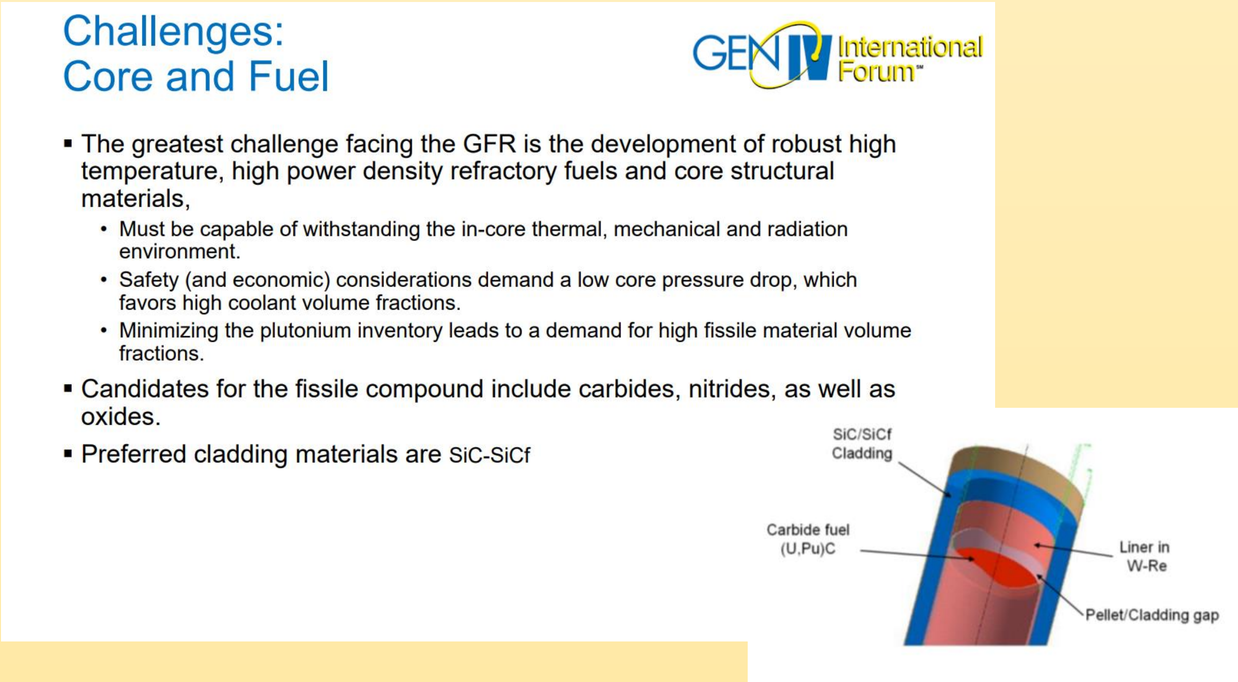
ALLEGRO is an experimental reactor that has been developed in the framework of the V4G4 consortium.

ALLEGRO has three decay heat removal systems, two main primary loops with an additional loop to test high temperature components.

The objective of ALLEGRO is to demonstrate the key GFR technologies.

5. Challenges and R&D for the fuel material:

The greatest challenge is the development of a robust high temperature and power density refractory fuels and core structural materials. Some R&D is under way such as the design of carbide fuel with SiC cladding.



6. Challenges and R&D for the decay heat removal system

Challenges of materials, components and He technology must be addressed. Difficulties related to the decay heat removal in LOCA are also concern. Some R&D for the challenges are under way. For example, the decay heat removal system design that can change flow path when forced convection change to natural convection in accidental condition.