Flibe Transmutation and Power Conversion

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Thermodynamics

- The free energy of formation for BeF_2 is –106.9 Kcal/g-atom of F at 1000K.
- The free energy of formation for TF is –66.2 Kcal/g-atom of F at the same temperature.
- Based on thermodynamics, we get

$$X_{BeF2}X_{T2}/X_{TF}^2X_{Be} = 6.4X10^{17}$$

$$X_{BeF2} = 0.33,\ X_{Be} = 1.0,\ X_{T2} = 10^{-8}$$

Which gives $X_{TF} = 10^{-13}$

Flibe Transmutation

• The transmutation of flibe/flinabe has been calculated the results report in previous meeting.

• The flibe/flinabe transmutation produces TF and F_2 which needs to be controlled.

• REDOX reaction has to be established to reduce the TF and F_2 into reduced form.

•Thermodynamic calculation shows that Be can be used to form the REDOX reaction.

Flibe Transmutation (Continue)

- The free energy of formations for FeF_2, VF_4, VF_5 etc all in the range of 70 Kcal/g-atom. They will not react with TF with a concentration in the order of 10^{-13}.
- Conclusion: Be has the ability to reduce TF and F_2 to a very low TF concentration. Whether kinetic can reduce the TF and F_2 fast enough has to be determined experimentally. To carry out experiment with X_{TF} of 10^{-13} is a challenge.

Power Conversion

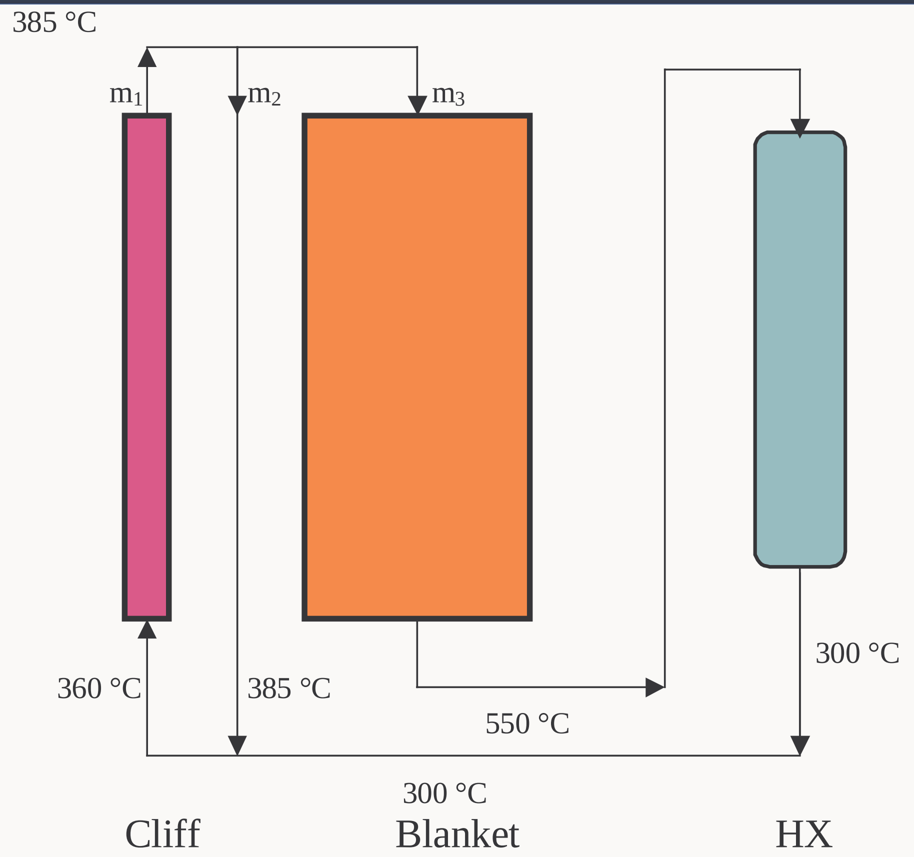
- The coolant temperature is dominated by the CLIFF temperature.
- The CLIFF temperature reported at the last APEX meeting was 360°C and 385°C.
- From energy and mass balance, the best we can do is to get the overall coolant temperature to 300°C and 550°C.

Power Conversion (Continue)

While 550C is acceptable for power conversion, 300C is too close to the melting temperature.

Further improvement is required.

Coolant Arrangement

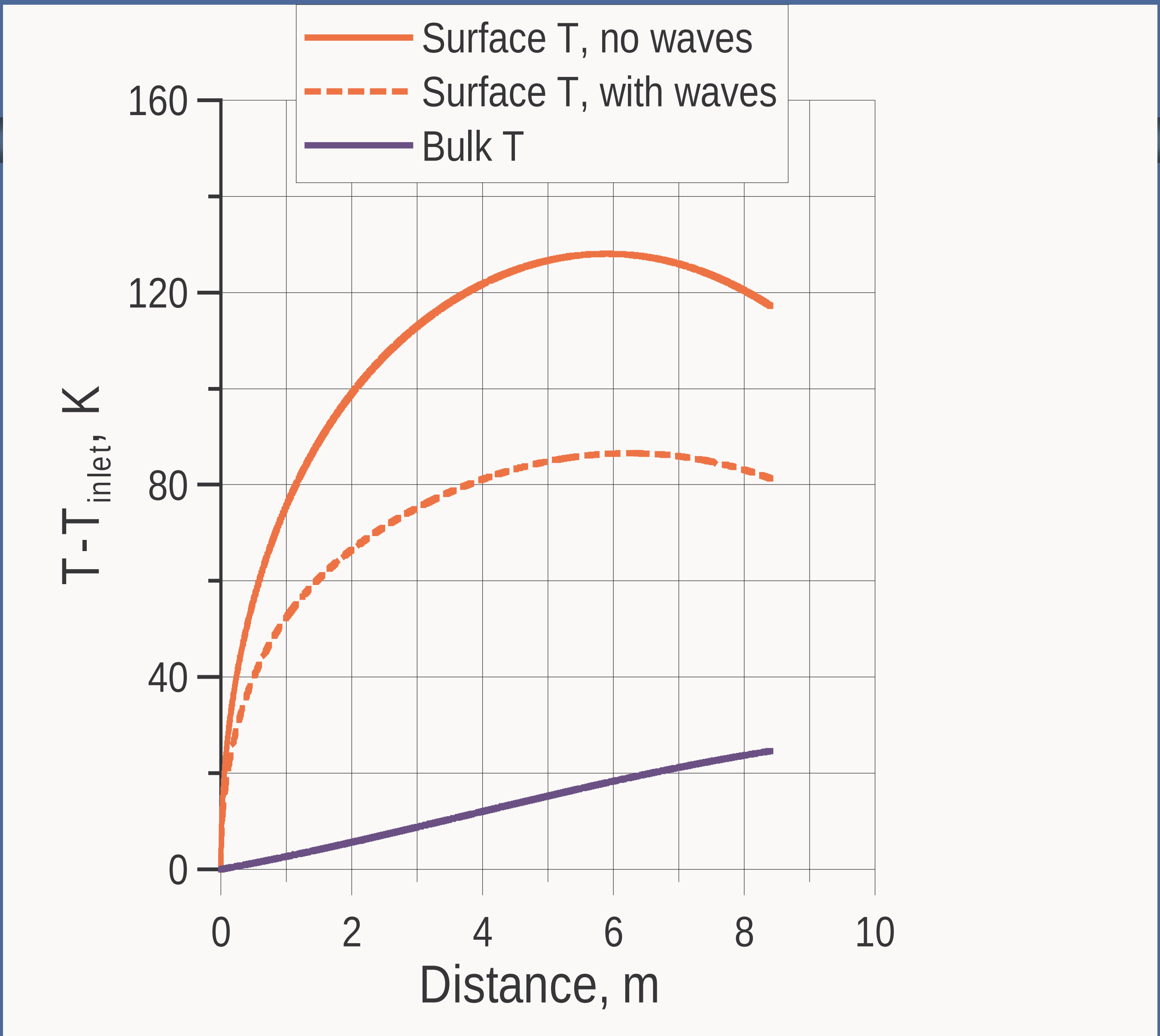


m_1=19000 Kg/s, m_2=13500 Kg/s, m_3=5500 Kg/s

Heat Transfer Improvement

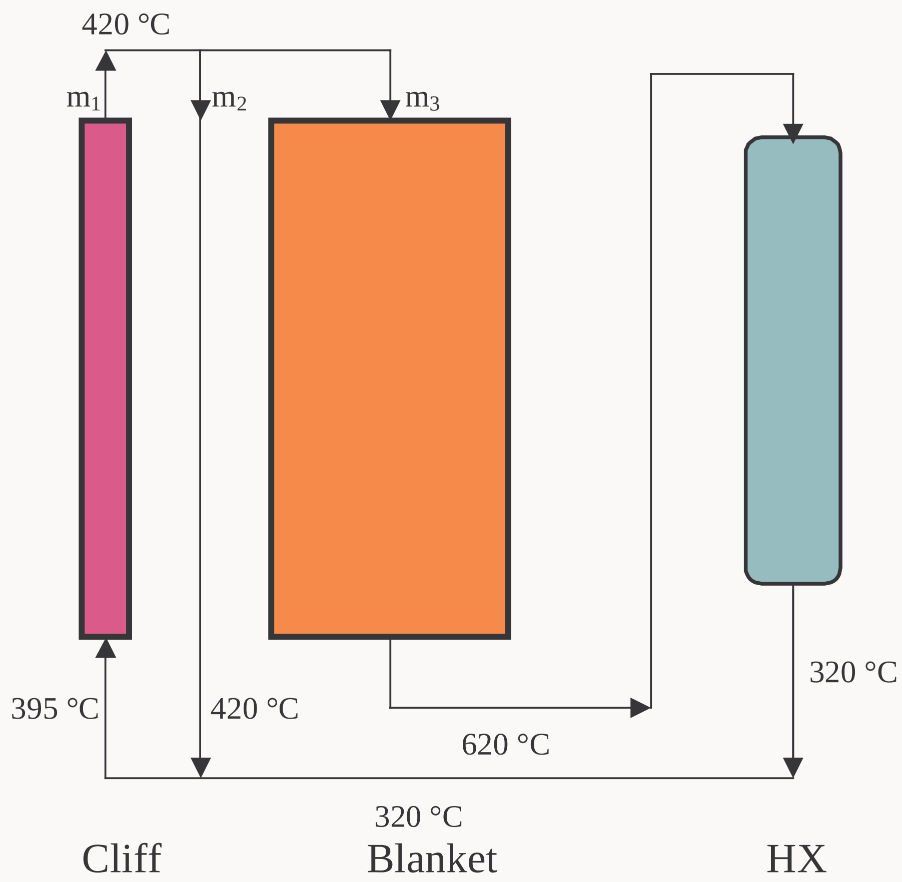
- The recent heat transfer calculation by Sergey includes the effect of surface wave.
- The heat transfer increased by about 40%.
- This improvement leads to the improvement of power conversion.

APPLICATION TO CLiFF



Coolant Arrangement

(With Improved Heat Transfer)



m_1=19000 Kg/s
m_2=15200 Kg/s
m_3=3800 Kg/s

Power Conversion

- The coolant temperatures are now 320°C and 620°C, respectively.
- We can also change the temperature to 350°C/590°C, if is necessary.
- Both those temperatures can excellent for power conversion.

Power Conversion(Continue)

- While the 590°C temperature enable us to go to a high performance steam cycle with an estimated efficiency of ~48%, the 620°C temperature leads to the possibility of using a He cycle.
- The optimum temperature to be selected depends on the melting temperature of flinabe.

Questions

- What is the melting temperature?
- What do we need to do to assure the 480°C surface temperature?
- What do we need to do to assure the heat transfer improvement? What is the MHD effects?