Cycle Optimisation and Heat Exchanger Network (HEN) Design in Oxy-combustion Power Cycles

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INTRODUCTION

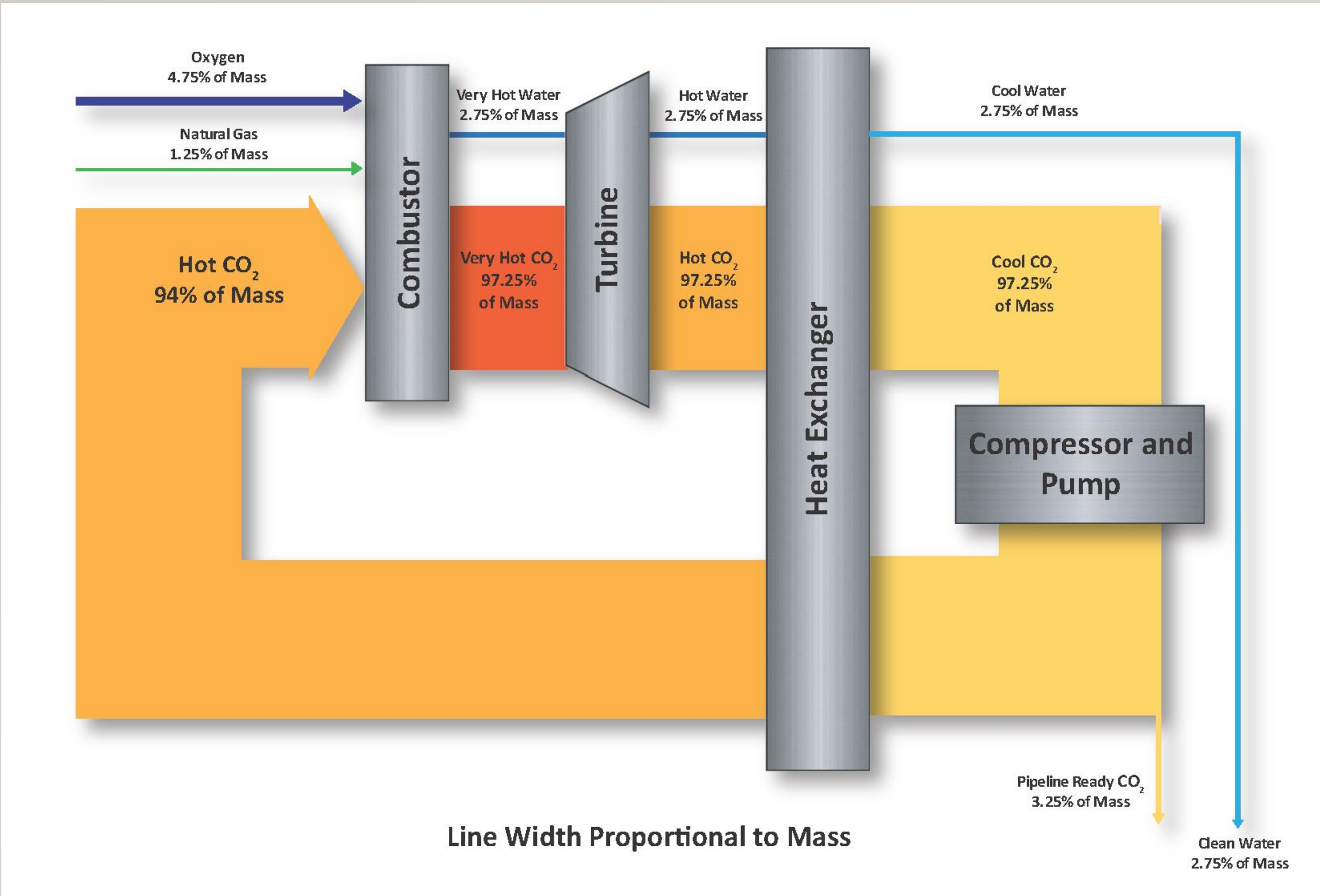

Fig.1. NetPower Cycle

The oxy-combustion is a capable technology in carbon capture and storage with relatively more advantages compare to other techniques.
Although several Oxy-combustion cycles are proposed and studied by thermodynamic analysis only two cycles of CES and Allam (NetPower) are currently in demonstration phase, both funded by DOE in the US.

Heatric Company supplies four printed circuit heat exchangers (PCHEs) for NetPower to commission the 50 MW demonstration plant in Texas .

Fig 2. Heatric heat exchanger used for NetPower cycle

METHODOLOGY

NetPower Plant include three main parts:
1.NetPower cycle
2.Recycle compression loop
3.Carbon dioxide purification and compression
In this article NetPower cycle and recycle compression loop are modeled using Aspen Plus.

The Air Separation Unit, CO_2 purification compression unit, utility and offside unites are extracted from IEA report 2015 and these are considered constant in this model (IEA 2015 report). Process flow diagram (PFD) of the model is shown in Fig. 2

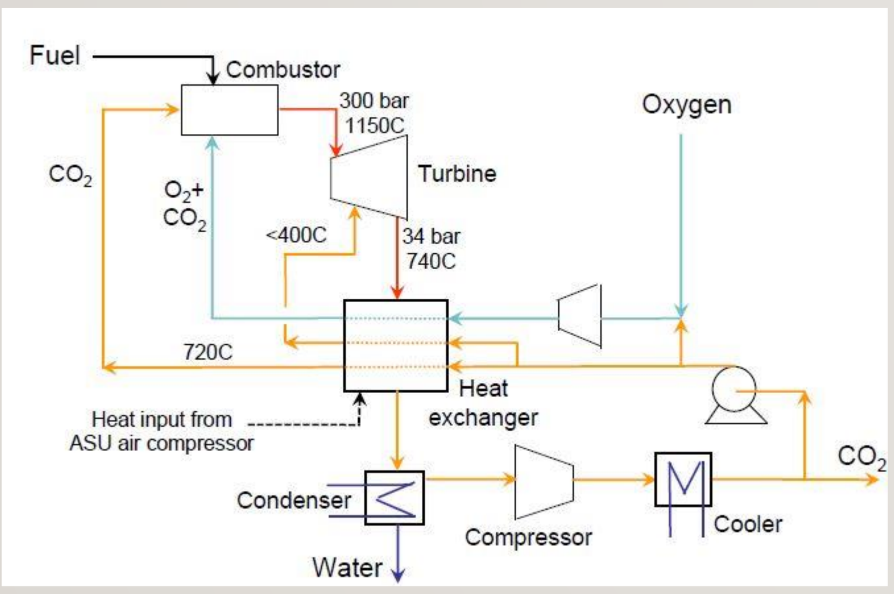

Fig 3.NetPower Schematic diagram

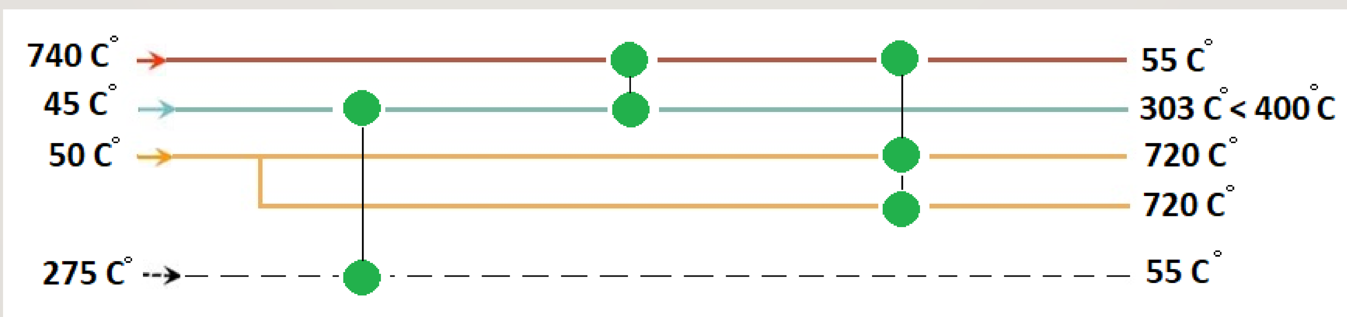

Fig 4. Heat Exchanger Network (HEN) Design for NetPower Cycle

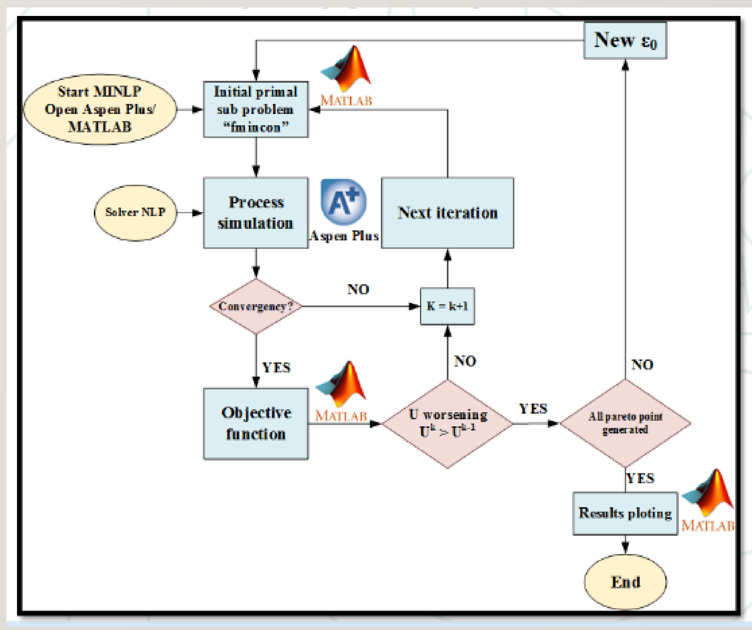

Fig 5. Optimisation algorithm by joint Aspen to MATLAB

RESULTS AND DISCUSSION

The following parameters should be considered to design and evaluate cost of heat exchange for NetPower plant:

1. Heat recovery with multi-stream heat exchanger saves energy cost by reducing hot and cold utilities. The capital cost (CAPEX) of utilities and operational cost (OPEX) of utilities are reduced
2. The capital cost of heat exchanger price will increase by lower ΔTmin
3. In order to reduce pressure dropping in multi-stream heat exchanger, the CAPEX will increase but energy cost and OPEX will drop.
4. The efficiency increasing and operational energy cost reducing by lower ΔTmin.

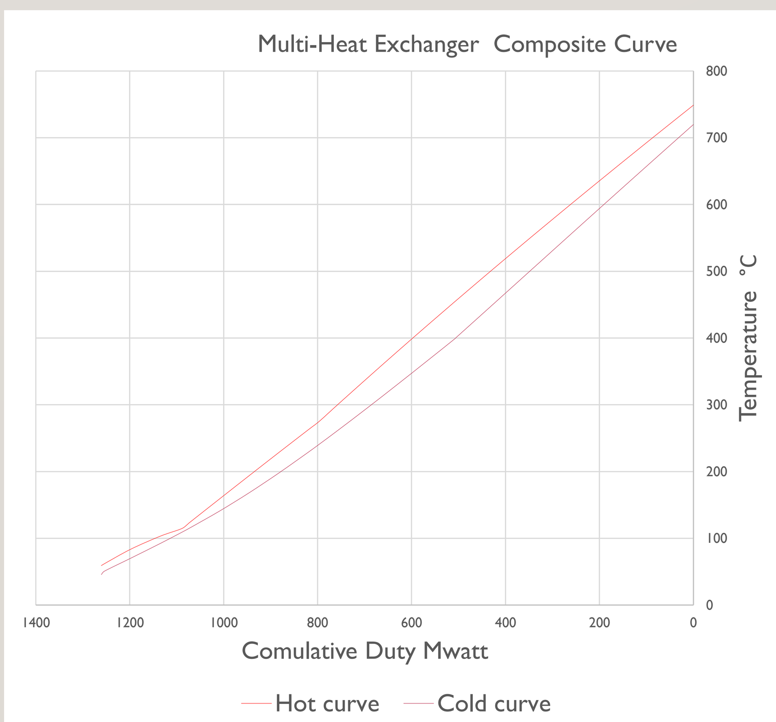

Fig.6 Composite curve

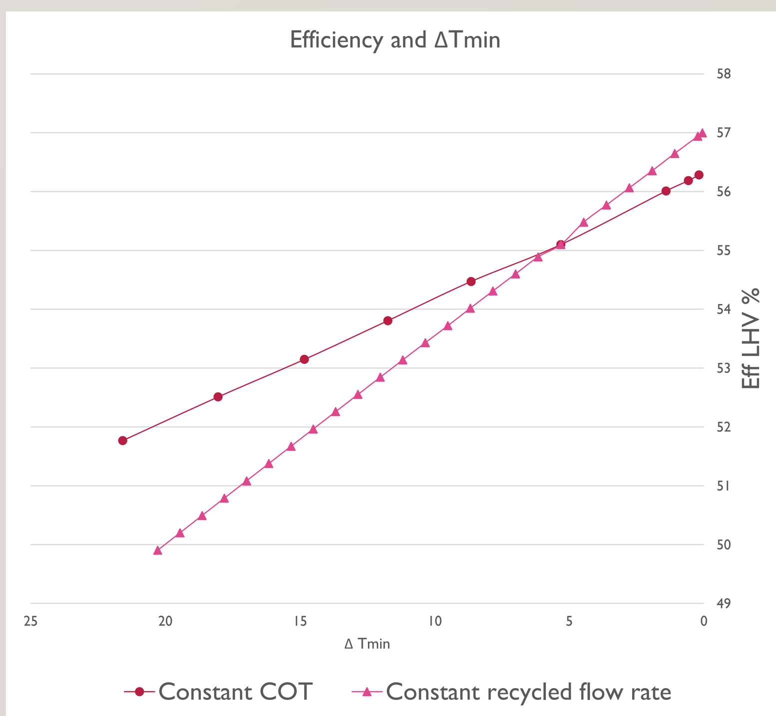

Fig.7 Efficiency related to ΔTmin with both constant COT 1150°C and constant recycle flow rate

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Sample References

[1] L. Mancuso, N. Ferrari, C. Paolo, E. Martelli, and M. Romano, “Oxy-combustion turbine power plants. Report: 2015/05,” *Ieaghg*, no. August, 2015.
[2] F. Climent Barba, G. Martínez-Denegri Sánchez, B. Soler Seguí, H. Gohari Darabkhani, and E. J. Anthony, “A technical evaluation, performance analysis and risk assessment of multiple novel oxy-turbine power cycles with complete CO2capture,” *J. Clean. Prod.*, vol. 133, pp. 971–985, 2016.
[3] Varasteh, H., Gohari Darabkhani, H., “Sensitivity analysis of the Heat Exchanger Design in NetPower Oxy-Combustion Cycle for Carbon Capture” International Journal of Energy and Power Engineering, Vol 12, No. 3, 2018, PP 231-239
[4] J. Davison, “Techno-Economic Assessment of Oxy- Combustion Turbine Power Plants with CO 2 Capture Outline of Presentation Background and scope of the study,” no. October, 2015.