This sample file first appeared in Thermoflow 29 (2020).

This is a design-point heat balance model of an intercooled recuperated oxyfuel CO2 gas turbine cycle, aka 'Allam Cycle'. It's is an example of a thermal power cycle, burning natural gas, that produces CO2 as a product stream for industrial use or sequestration.

Basic cycle parameters are listed below:
>> Gross power generation ~300 MW
>> Cycle PR ~10
>> TIT ~1150C / (2100F)

This model is similar to published descriptions of the 'Allam Cycle'. However, it was constructed using only publicly available information together with THERMOFLEX default inputs and assumptions to account for unavailable information. No proprietary information was included in the development of this model.

Model Details:

> System 'size' is established by the CO2 flowrate entering the comperssor train, specified as input to Source [5]. This flowrate was set to yield a gross power of ~300MW.

> Low pressure of ~30 bar is assumed, with high pressure at combustor inlet of ~300 bar to yield overall cycle PR ~10.

> THERMOFLEX's cooled turbine stage is used to model the expander in seven stages. Inputs to these icons for cooling effectiveness, acceptable metal temperatures, and TBC thickness and thermal conductivity are all left at default values, known to be reasonable to model conventional 'F-class' gas turbines. The only non-default input to these icons is the uncooled isentropic efficiency is assumed to be 88%

> THERMOFLEX's standard gas/air compressor model was used together with heat adders to intercool the compression process. The default 90% polytropic compressor efficiency is assumed for all stages.

> Final flue gas treatment is handled by a 'black-box' that separates H2O, and residual N2, Ar introduced by the ASU from the CO2 stream. No power is expended in this simplified process. The compressor inlet flow is assumed to be pure CO2.

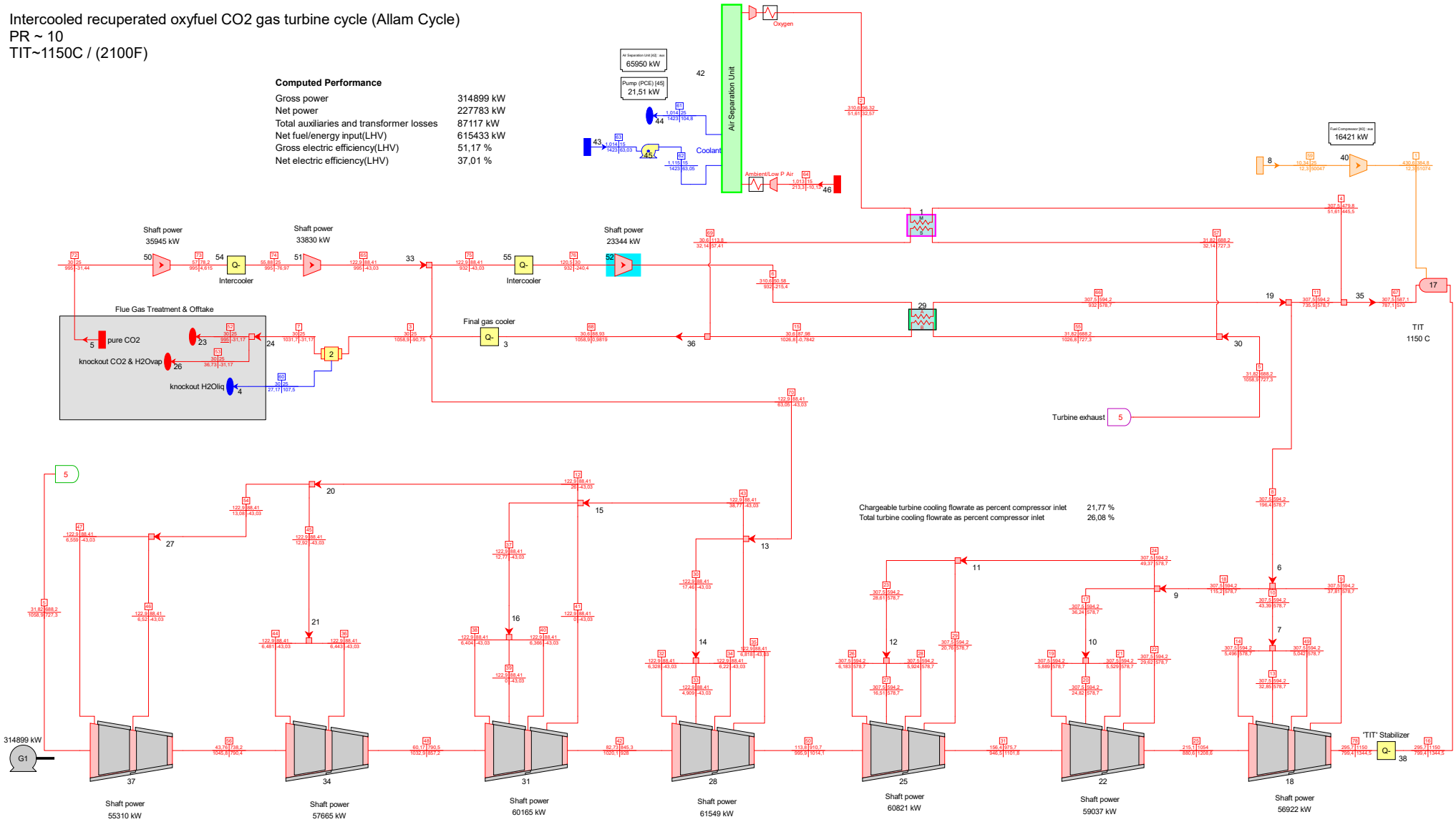
> Thermodynamic properties use NIST's REFPROP routines, making the overall calculation slower than for typical THERMOFLEX models.

> A control loop is used to reach desired TIT with assumed zero excess O2 in the combustor outlet gases. A heat adder icon, entitled 'TIT Stabilizer' is included as an artifice, used only to aid the calculation process. It should add/remove no heat from the cycle in the final computed result.

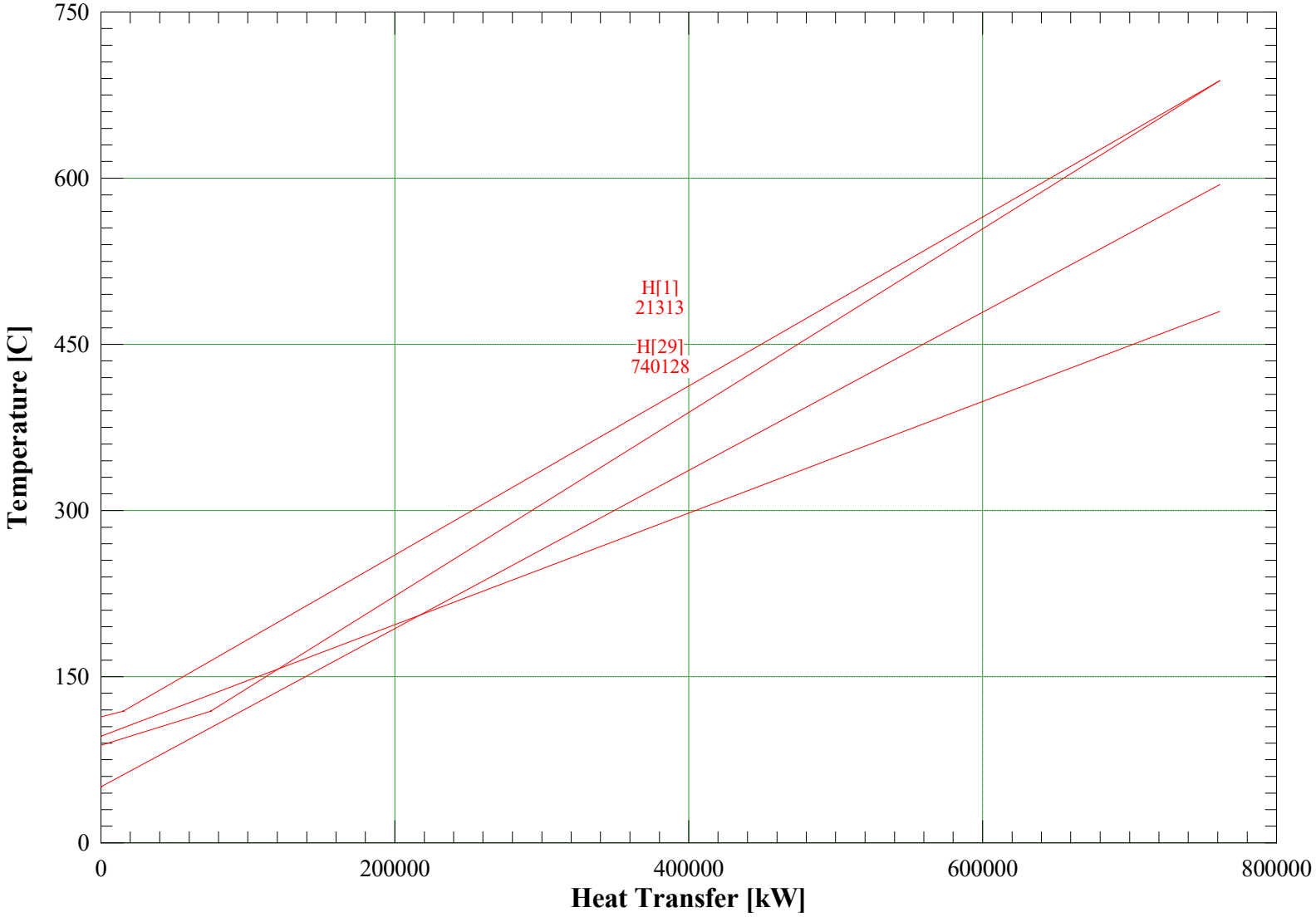
Intercooled recuperated oxyfuel CO2 gas turbine cycle (Allam Cycle)
PR ~ 10
TIT~1150C / (2100F)

Computed Performance

Gross power	314899 kW
Net power	227783 kW
Total auxiliaries and transformer losses	87117 kW
Net fuel/energy input(LHV)	615433 kW
Gross electric efficiency(LHV)	51,17 %
Net electric efficiency(LHV)	37,01 %



Heat Recovery



Cooled Turbine Stage: Open Loop Allowed [25] - Expansion H-S Diagram