Imposing an energy balance about the heat source, one can write:

$$\dot{m} = \frac{Q_{in}}{H_l(T_o) - H_l(T_r) + \Delta H_g(T_o)} \quad (1)$$

The primary radiator functions as a condensor and rejects heat at constant temperature. Applying the radiative heat transfer law to find the radiator area results in:

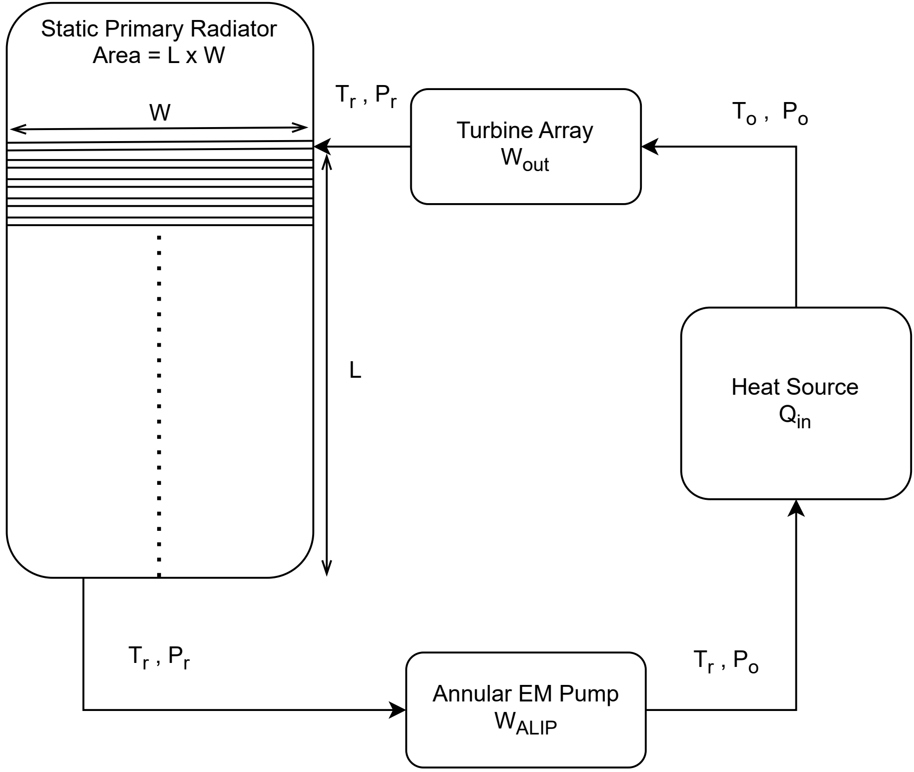
$$A = LW = \frac{\dot{m}\Delta H_g(T_r)X_r}{\epsilon\sigma_b {T_r}^4} \quad (2)$$

Where ϵ is the surface emissivity coefficient and X_r is the sodium vapour quality at the radiator inlet

The above equations in $\dot{m}$ and T can be numerically solved using the sodium thermophysical property tables if the turbine pressure ratio, TPR, and T_o is known. The maximum thermal to electrical conversion efficiency is then:

$$\eta_{th} = \eta_{gen}\frac{W_{out} - W_{ALIP}}{Q_{in}} \quad (3)$$

Where η_{gen} is the generator's efficiency



For an incompressible fluid like liquid sodium, W_{ALIP} can be expressed as:

$$W_{ALIP} = F_p \Delta P \dot{V} \quad (4)$$

Where F_p is a factor to account for frictional, form and expansion losses in the coolant circuit and $\dot{V}$ is the volumetric flow rate. Using the liquid sodium density data in the thermophysical property tables, one can convert $\dot{V}$ to $\dot{m}$. Further, ΔP can be expressed in terms of the TPR. Substituting in (4), one gets:

$$W_{ALIP} = F_p P_o(1 - TPR)\frac{\dot{m}}{\rho_l(T_r)} \quad (5)$$

If the value of TPR and T_o is known, one can use the isentropic relations and sodium entropy data tables to find T_r and X_r:

$$T_r = T_o TPR^{\frac{\gamma-1}{\gamma}} \qquad \& \qquad X_r = \frac{S_g(T_o) - S_g(T_r)}{S_g(T_r) - S_l(T_r)}$$

Finally, using (1), (5) and the fact that $W_{out} = \dot{m}(H_g(T_o) - X_r\Delta H_g(T_r) - H_l(T_r))$, one can rewrite (3) as:

$$\eta_{th} = \eta_{gen}\frac{H_g(T_o) - X_r\Delta H_g(T_r) - H_l(T_r) - \frac{F_p P_o(1-TPR)}{\rho_l(T_r)}}{H_l(T_o) - H_l(T_r) + \Delta H_g(T_o)} \quad (6)$$