



Designing the Optimal Waste Heat Recovery Unit for an ORC Plant

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MUHIBBAH
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A member of the Muhibbah Engineering group of companies



- Introduction to CiTECH
- Fundamentals of Heat Transfer
- How to Improve Heat Exchanger Size & Cost
- Case Study

Eight Decades of Heat Recovery

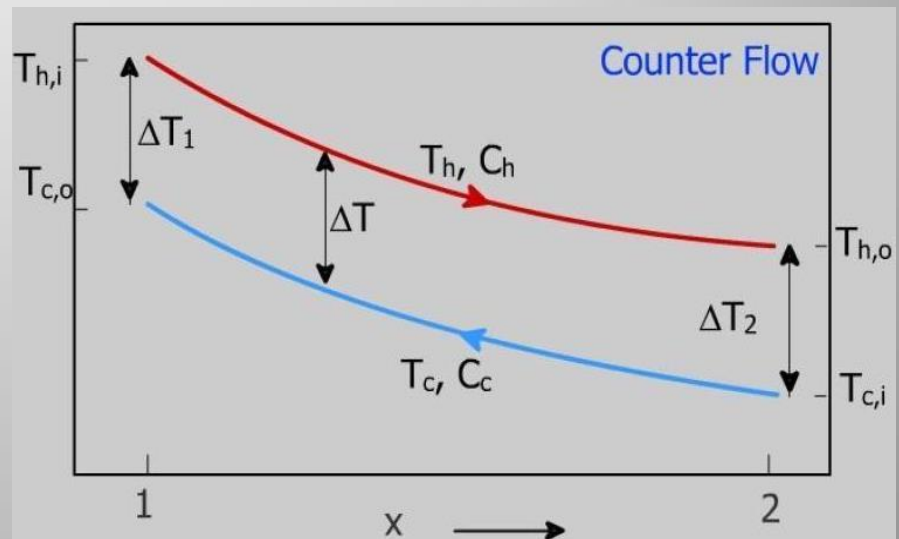


The main driving force to produce a cost effective heat exchanger is having a significant difference in temperature between both the heating medium and hot exhaust gas.

$$Q_{\text{tot}} = UA\Delta T_{\text{LMTD}} \quad (\text{Eq.1})$$

$$\Delta T_{\text{LMTD}} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} \quad (\text{Eq.2})$$

$$Q_{\text{tot}} = \dot{m}c_p\Delta T \quad (\text{Eq.3})$$

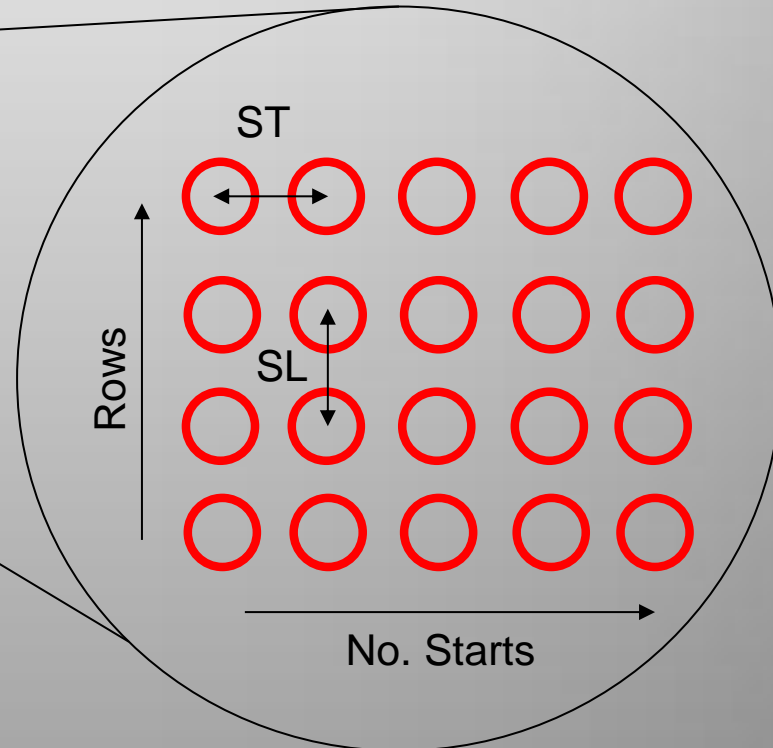
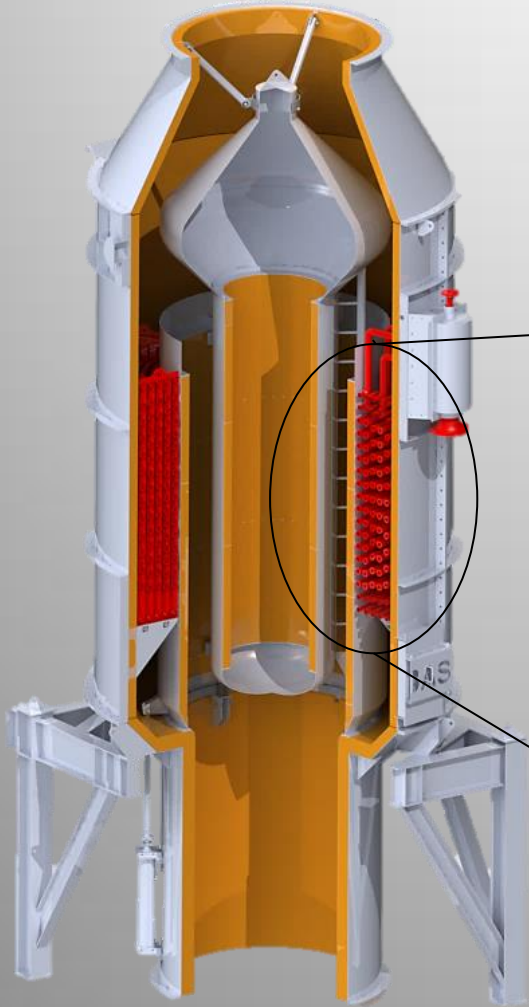


There is a fine balance between trying to create a large log mean temperature difference and having a high process flow rate.

Straight Tube Heat Exchange Model

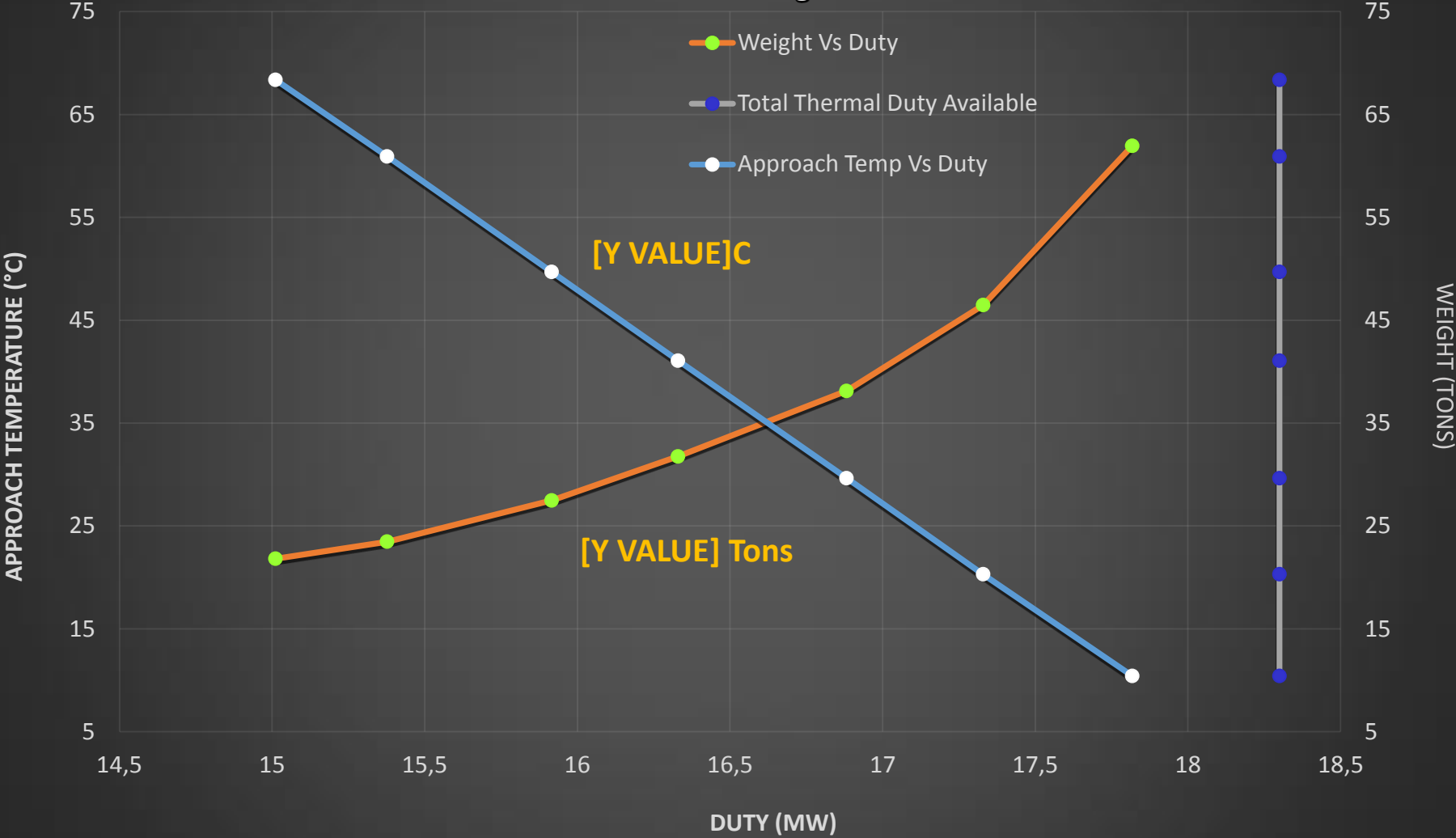
$$ST_{\min} = OD_{\text{pipe}} + FH + K \quad (\text{Eq.4})$$

$$\Delta P_{\text{process}} = 0.5\rho(L/D)u^2C_f \quad (\text{Eq.5})$$

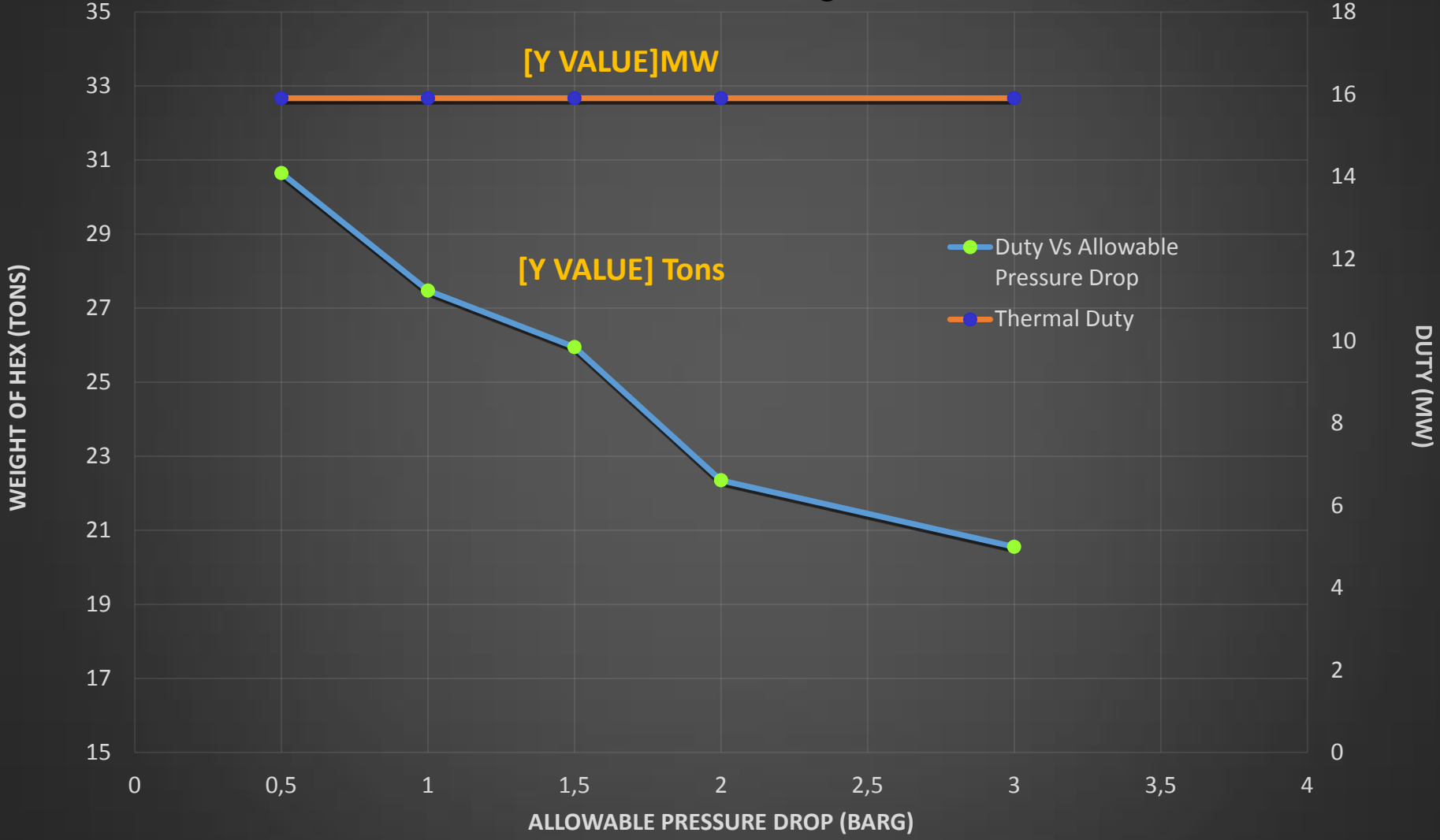


ORC Parameters	BASE CASE
Heating Medium	Therminol 66
Inlet/Outlet Process Temperature	160°C / 300°C
Exhaust Gas Temperature Inlet/Outlet	530°C/ 210°C
Process Pressure Drop	1barg
Exhaust Gas Pressure Drop	150mmH ₂ O
Thermal Duty	15.9MW
Process Flow (kg/s)	49.17kg/s

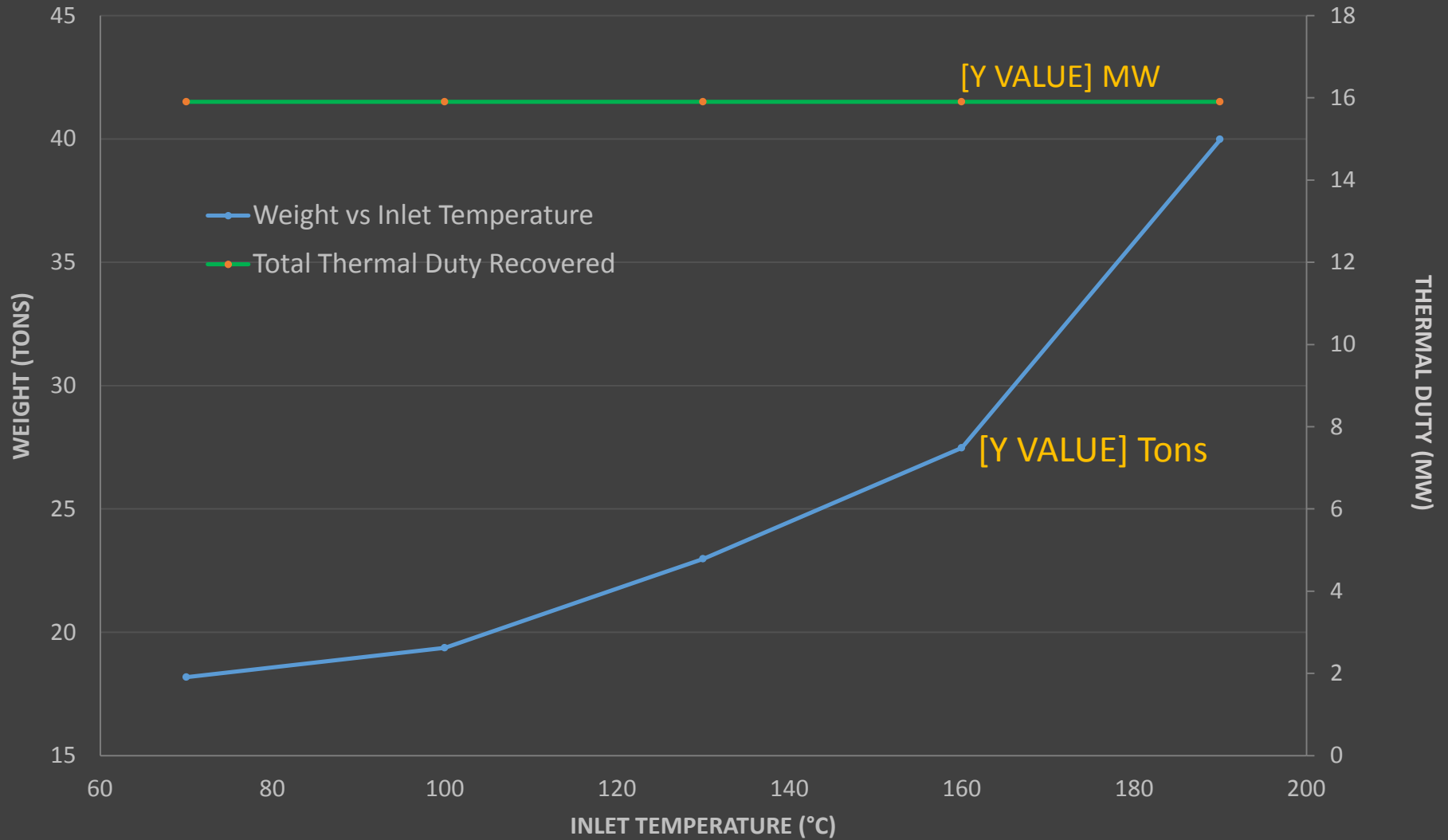
The Effects on the Change in Approach Temperature on the Weight of the Heat Exchanger



The Effects of Increasing Allowable Pressure Drop on the Weight of a Heat Exchanger



Change in Inlet Temperature Vs Weight of Heat Exchanger



ORC Parameters	Base Case	Optimal Case
Inlet Process Temperature	160°C	100°C
Outlet Process Temperature	300°C	300°C
Approach Temperature	50°C	110°C
Process Pressure Drop	1barg	2.5barg
Weight	27.472 Tons	16.648 Tons
Thermal Duty	15.9MW	15.9MW
Process Flow	49.17kg/s	36.08kg/s
Cost (Relative Figure)	£X	£0.7X

**Thank you
and
any questions?**