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APPENDICES

Appendix A Upgrading Process Flowsheet Implemented in PRO/II

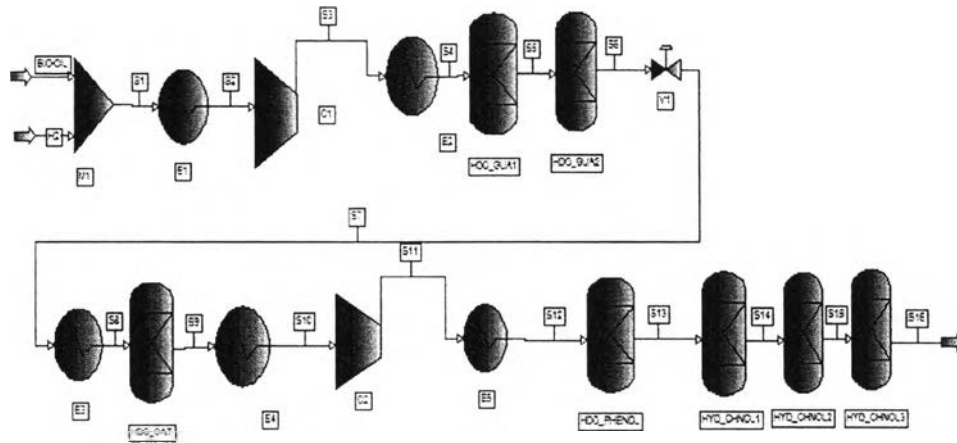


Figure A1 Flowsheet of the upgrading process implemented in PRO/II.

Appendix B The Properties of Hot and Cold Streams Before and After Making the Pinch Analysis

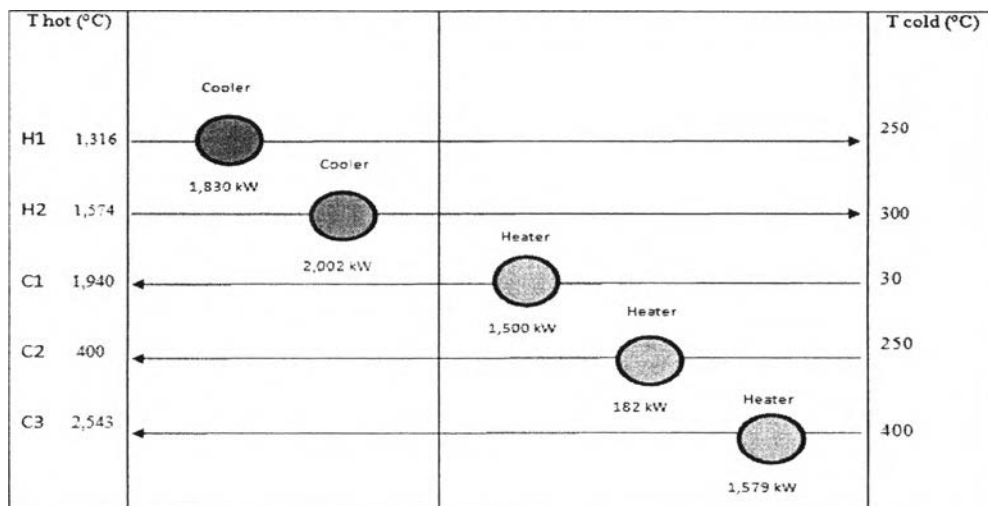


Figure B1 Grid diagram of hot and cold stream before making heat integration into Alternative 1.

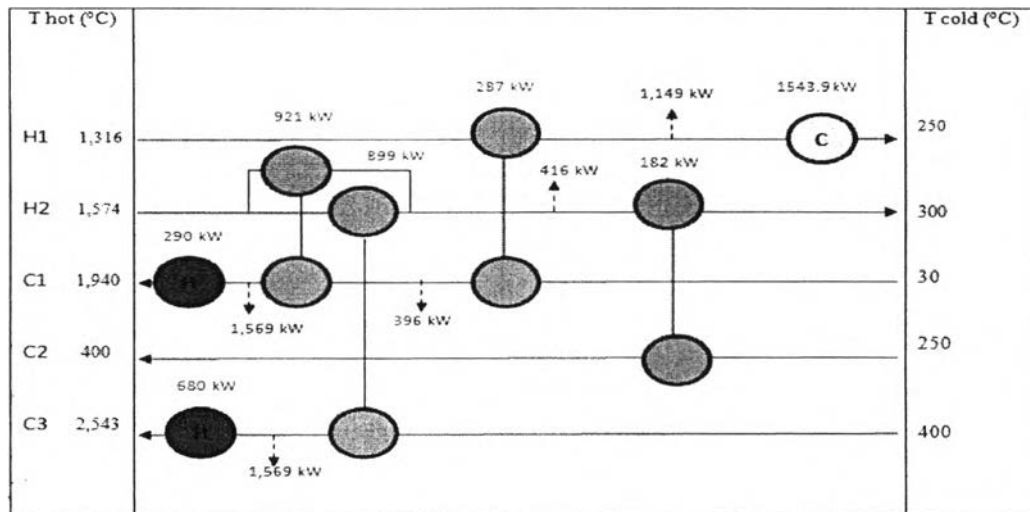


Figure B2 Grid diagram of hot and cold stream after making heat integration into Alternative 1.

Appendix C Calculation of Energy Consumption for *Leucaena Leucocephala* Drying

The energy consumption for drying (H_{drying}) of *leucaena leucocephala* was calculated using thermodynamic calculation. The temperature difference employed in this equation was 55 °C because the collected *leucaena leucocephala* were kept at room temperature (25 °C) in the laboratory after dewatering and was dried at 80 °C. From the thermodynamic calculation;

$$\begin{aligned}
 H_{\text{drying}} &= H_{\text{vap}} + H_{\text{sensible}} \\
 &= mL + m[C_p(\Delta T)] \\
 &= (1,980\text{kg})(2,305.4 \text{ kJ/kg}) + (1,980\text{kg})(340.57-101\text{kJ/kg}) \\
 &= 5,039 \text{ MJ/11 tons } leucaena \ leucocephala \\
 &= 458 \text{ MJ/tons } leucaena \ leucocephala
 \end{aligned}$$

Remark; H_{drying} : energy usage in drying step (MJ)

H_{vap} : heat of vaporization (MJ/kg water)

H_{sensible} : sensible heat (MJ/kg water)

m : mass of vapour

C_p : calorific value of water (4.2 J/g)

L : latent heat

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