Energy, Exergy and Advanced Exergy Analysis of a Milk Processing Factory

Energy, exergy and advanced exergy methods are used in this study to analyse a milk processing facility which is one of the largest energy consumers within the food industry in Denmark. While a conventional energy analysis maps the energy flows of the system and suggests opportunities for process integration, an exergy analysis pinpoints the locations, causes and magnitudes of thermodynamic losses. The advanced exergy analysis further identifies the real potential for thermodynamic improvements of the system by splitting exergy destruction into its avoidable and unavoidable parts, which are related to technological limitations, and into its endogenous and exogenous parts, which illustrate the interactions between the different sub-systems. This analysis is based on actual factory data from one of Europe's largest dairy producers: the complete production line is modelled, and includes the production of milk, cream and milk powder. The results show the optimisation potential based on 1st and 2nd law analyses. An evaluation and comparison of the applicability of exergy methods, including advanced exergy methods, to the dairy industry is made. The comparison includes typical energy mappings conducted onsite, and discusses the benefits and challenges of applying advanced thermodynamic methods to industrial processes.

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