Exergoeconomic optimization of an ammonia–water hybrid absorption–compression heat pump for heat supply in a spraydrying facility

Spray-drying facilities are among the most energy intensive industrial processes. Using a heat pump to recover waste heat and replace gas combustion has the potential to attain both economic and emissions savings. In the case examined a drying gas of ambient air is heated to 200°C yielding a heat load of 6.1 MW. The exhaust air from the drying process is 80°C. The implementation of an ammonia–water hybrid absorption–compression heat pump to partly cover the heat load is investigated. A thermodynamic analysis is applied to determine optimal circulation ratios for a number of ammonia mass fractions and heat pump loads. An exergo economic optimization is applied to minimize the lifetime cost of the system. Technological limitations are imposed to constrain the solution to commercial components. The best possible implementation is identified in terms of heat load, ammonia mass fraction and circulation ratio. The best possible implementation is an 895 kW heat pump with an ammonia mass fraction of 0.82 and a circulation ratio of 0.43. This results in economic savings with a present value of 146,000 € and a yearly CO₂ emissions reduction of 227 ton.