Understanding Specific Power

Specific power is a useful way to compare air separation plant efficiencies. However, when evaluating integrated liquefier air separation plants the results can sometimes be misleading since the specific power calculation only looks at the total liquid production and does not account for the product split [Liquid Oxygen ("LOX") product versus Liquid Nitrogen (LN_2) product as a percentage of the total liquid product] or other gaseous products.

The product split can have a significant impact on specific power evaluation. Two plants producing the same amount of total liquids can have considerably different specific powers depending on the product split. There are also variations in specific power due to the plant cycle; however compressor sizing has similar effects with all designs.

Consider the following typical cases. Case 1 is a mixed mode operation where the feed air compressor output is matched to the LOX requirement of 50% of the total liquid production and the recycle compressor capacity is matched to the total liquids output (100% consisting of 50% LOX and 50% LN). In other words, the main air compressor size was dictated by the amount of oxygen molecules needed for the required LOX production and the liquefier/refrigeration size (recycle compressor and expander sizes) was determined by the total liquid output. A typical specific power would be 0.77 Kwh/Nm3 based on total liquids produced (See FIGURE 2). No specific power credit is given for available gas products.

For our Case 2 (Max LOX) a larger feed air compressor capacity was required to provide the oxygen molecules needed for the maximized LOX production resulting in a product split of 83% LOX and 17% LIN As before almost the entire recycle compressor output is utilized to make similar refrigeration as Case 1. Hence, the recycle compressor will remain unchanged from Case 1. Please see Figure 2 graph showing the power split between the main air and recycle compressors for each case. However, Case 2 has higher specific power than Case 1 (See figure 3). This is due to the fact that while total liquid produced in the plant is the same for both Case 1 and Case 2 (e.g., similar recycle compressor load), for Case 2 the amount of LN_2 available as product is much less because the balance of LN_2 available from the plant is used as the reflux for the upper column for LOX production. The higher specific power in Case 2 is not due to inefficiencies in the process design but solely due to product split between LOX and LIN. Simply put, with a fixed refrigeration capacity (recycle compressor & expander capacity); the higher the LOX split, the higher the specific power. Figure 4 shows a typical effect of LOX production as a percentage of total liquid production on specific power (power per unit of production) for a POPLAR air separation plant with integral liquefier.

While there are numerous factors to consider when evaluating and comparing plant performance, one can

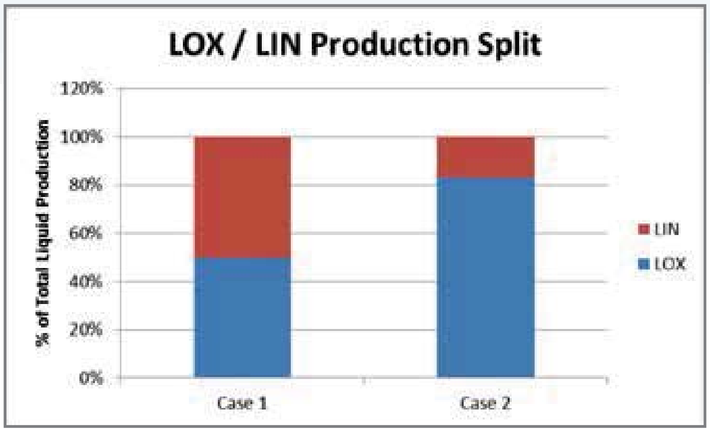

Figure 1 –Liquid Production Split

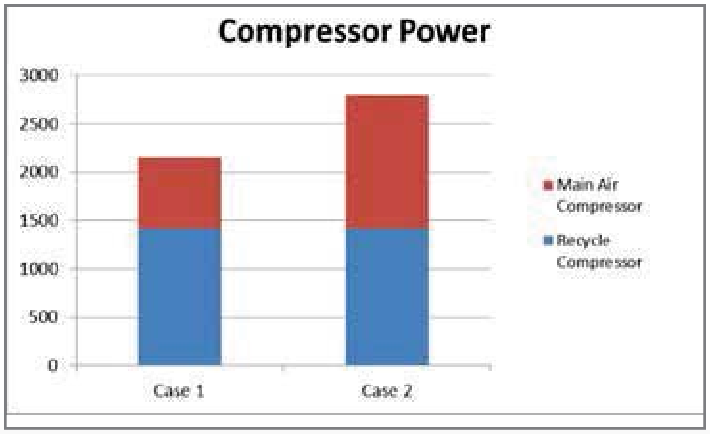

Figure 2 – Compressor Power Split

see from the above example that merely looking at the specific power and total liquid production when evaluating plant performance can result in a distorted conclusion. The product splits must be examined when using specific power for performance comparison.

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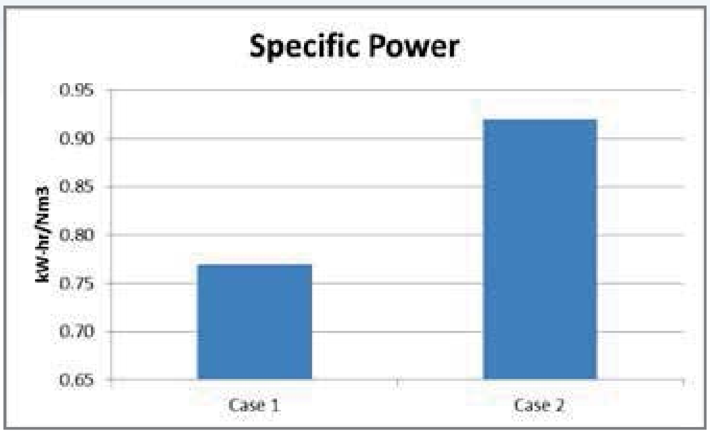

Figure 3 – Specific Power

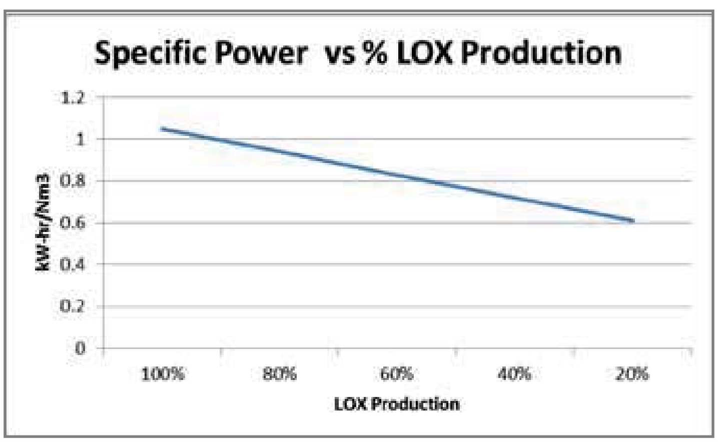

Figure 4 – Effects of LOX production split on Specific Power