Fisher INTERNATIONAL

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Does the Through Air Drying Tissue Process Really Use More Energy?

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Tissue machine energy consumption triggers a frequent topic of debate, especially between European and North American tissue engineers. There is general agreement about the tactics and best practices to operate any given machine, but the strategic questions of process and product design rarely achieve consensus.

The large percentage of advanced tissue processes in North America tends to elicit negative comments when considered regarding energy costs and carbon footprint, but North American consumers seem to crave the performance of advanced tissue products.

The most common advanced tissue process is TAD (Through Air Drying), and it is well known for the increased energy demand per ton. Newer advanced tissue making processes that also create a structured sheet have been introduced such as ATMOS, NTT, eTAD, and QRT with the expectation that they will reduce energy demand per ton.

Tissue Machine Energy Cost per Ton

Figure 1 takes a high-level look at average regional energy costs in USD per FMT (finished metric ton) for just the tissue machine energy. The width of the bars indicates the relative production volume for each region. This comparison is relevant for most business decisions, but it doesn't allow comparisons or conclusions as to energy efficiency. North America enjoys plentiful and low-cost natural gas that makes its energy efficiency appear higher than expected. That is probably a key reason that TAD has become so popular.

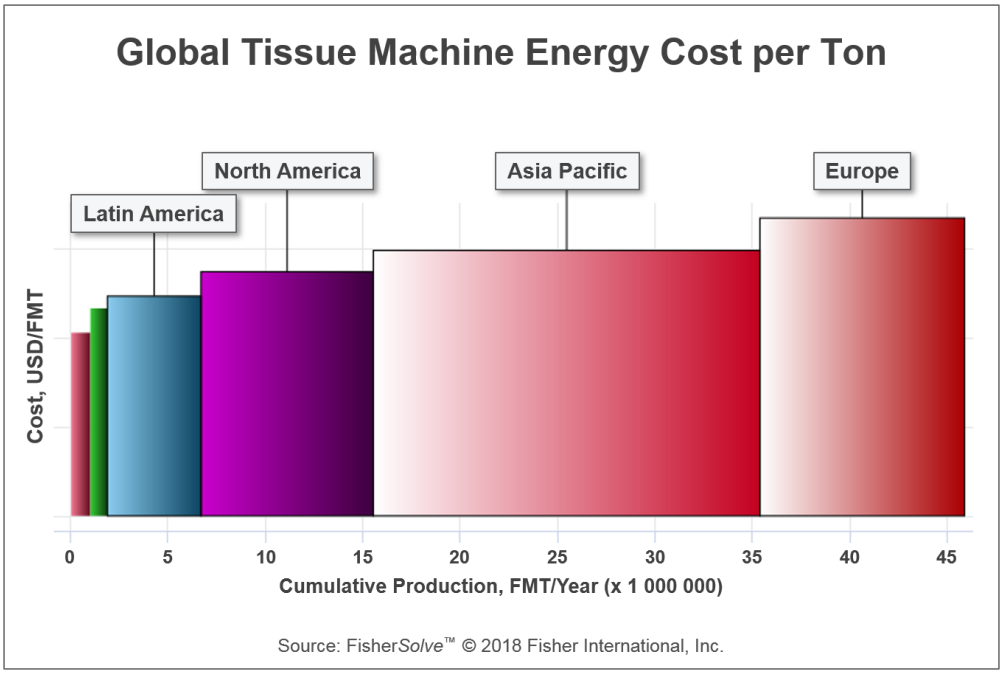

Figure 1

Tissue Machine Energy Consumption per ton

The Fisher*Solve*™ database offers an opportunity to separate these issues out and look at machine configuration and product design independent of local pricing. Figure 2 shows the same regional data expressed as gigajoules (GJ) per ton. Electric power consumption as MWh was converted to equivalent GJ/FMT to allow summation of fuel and power in one chart. Most regions require about four gigajoules of electrical energy per finished metric ton, but North America stands out with five GJ/FMT. The differences in heat energy are more substantial as Europe consumes 11.4 GJ/FMT, and North America consumes about 16 GJ per FMT.

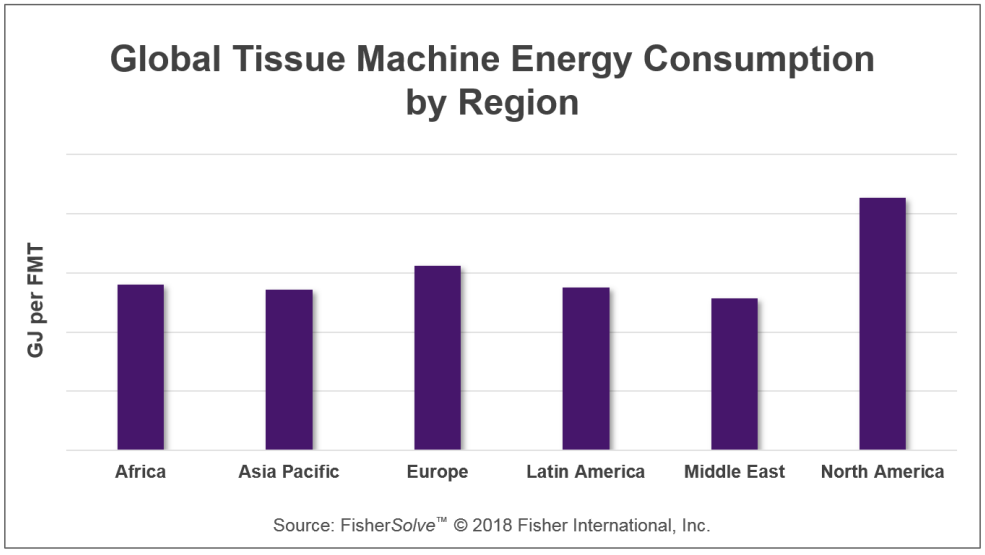

Figure 2

A benchmark from the literature[1] suggests a well-run modern design tissue machine should require 10.44 to 12.60 GJ/FMT.

Most of the world is running higher than that target in practice, and North America is consuming about twice as much as the benchmark.

This striking difference in energy consumption between regions requires further exploration.

Of course, consumers don't buy and use tissue by the ton, and this tends to complicate the discussion. Energy costs for electric power and fuel vary between and within regions making the cost per ton comparisons less useful for understanding the effects of the machine or product design. Pulp cost varies depending on site location, furnish type, and mill integration. This also clouds energy use comparisons between different products and processes operating under different fiber costs.

North American Tissue Production

Almost 40% of North American tissue production uses the advanced structured processes. TAD is still the predominant type of advanced process, and we know that the drying load imposed by no or limited mechanical dewatering has an energy cost. Vacuum dewatering before the TAD requires several times the electrical energy of conventionally pressed tissue. The air flow supply fans needed in the TAD section are another significant energy draw. The incremental cost of TAD electricity can be higher than the TAD fuel gas cost depending on the local pricing.

Alternative advanced technologies such as ATMOS, NTT, eTAD, and QRT also avoid excess direct pressing to maintain bulk to various degrees. This results in somewhat higher water loads per finished ton to the dryer in most cases. These processes also create a structured three-dimensional pattern in the sheet that impedes good Yankee dryer contact and drying rates. Again, the increased percentage of structured tissue production in North America tends to skew the energy consumption comparisons to other regions.

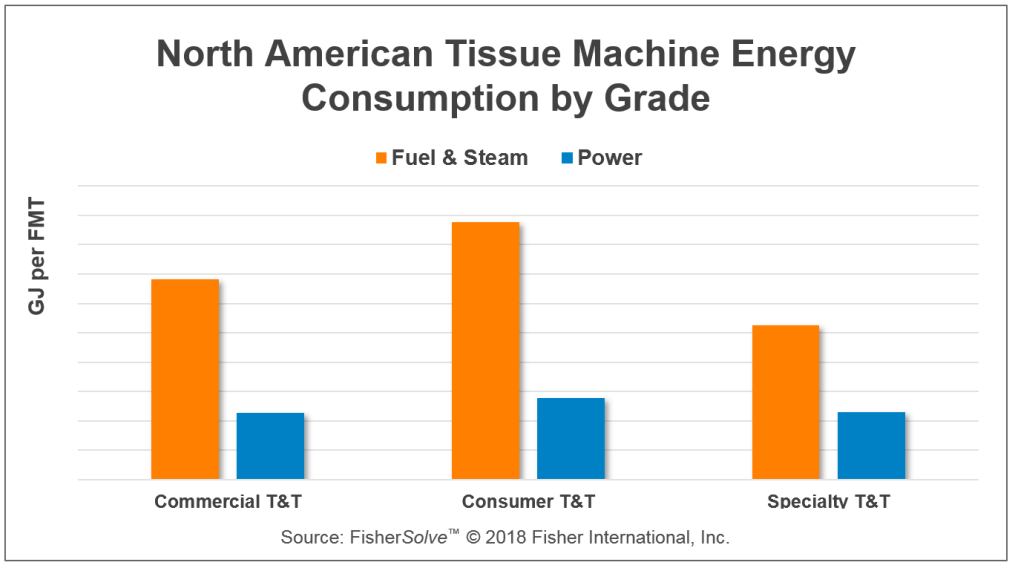

Figure 3

Fisher*Solve* data plotted in the Figure 3 above shows that electrical energy is slightly higher for the consumer or retail grades averaged for all tissue technologies in North America. This is expected as the consumer grades tend to place a higher value on softness and tend to overdry the sheet to get more effective creping versus most commercial or away-from-home products. Specialty grades drying heat energy is low due to less or no creping and much slower speeds resulting in lower intensity.

Figures 4 and 5 provide a direct comparison of North American tissue production energy consumption per ton of the finished products. The consumer tissue grade was selected as it is the most common grade with a large number of data points for both conventional and advanced tissue technology.

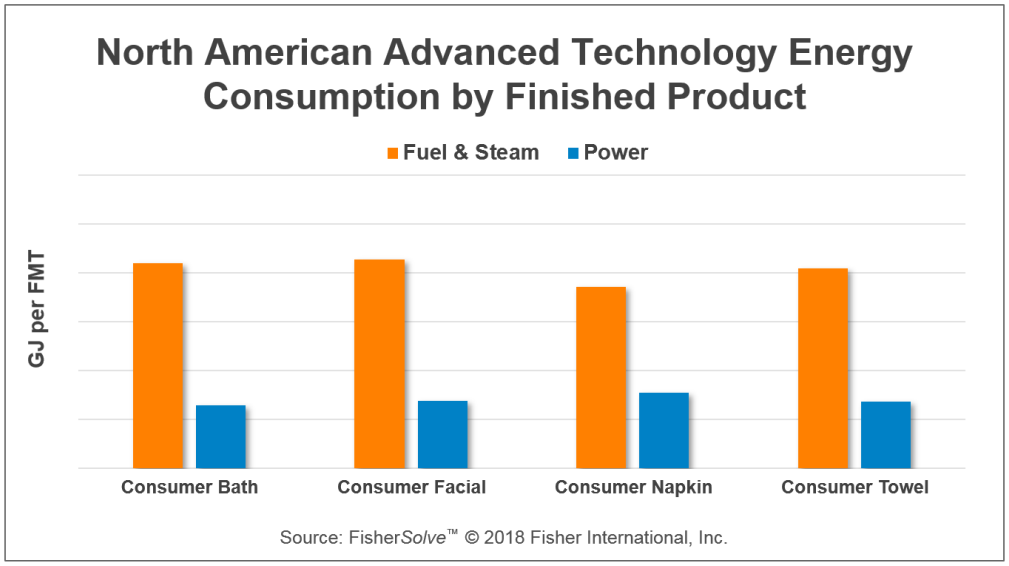

Figure 4

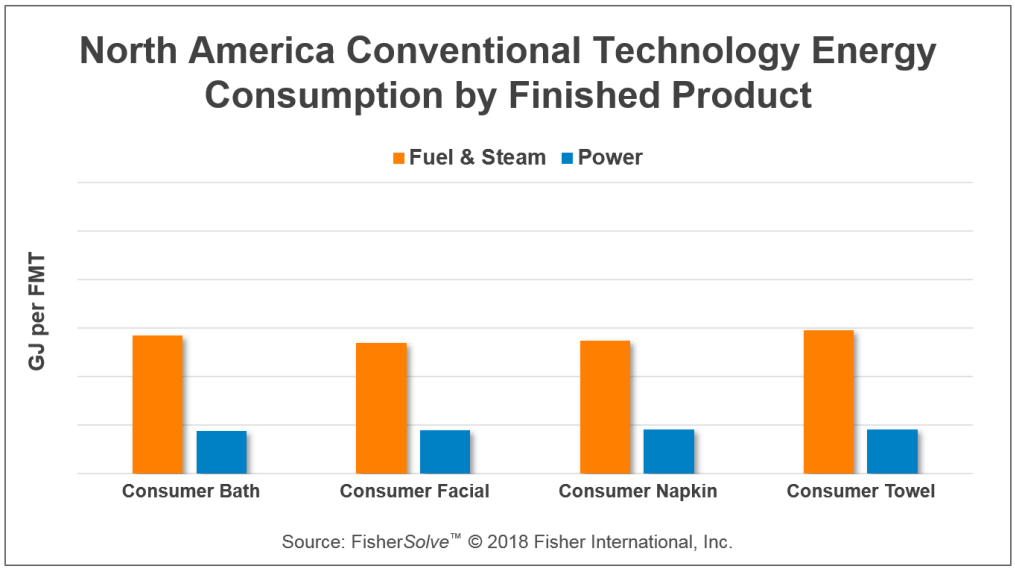

Figure 5

The first chart is for advanced structured tissue technology showing the increased energy consumption for each product format. The second chart is for conventional wet pressed technology and shows much lower electrical and heat energy values per ton as expected. Note that the scales on both charts are the same to allow direct visual comparisons. This confirms the original debate point that advanced tissue technology is an energy hog (at least per ton).

Tissue Machine Costs per Case

We've seen that energy consumption per ton of consumer or retail advanced tissue is significantly higher than a conventional tissue of the same grade and product format. However, this isn't the end of the story. People buy and use tissue products by the sheet and not by the ton.

Fisher*Solve* offers a better way to compare the tissue making processes than energy consumption per FMT. The Statistical Case Cost feature allows the basis weight of finished products to be adjusted to reflect the higher bulk and typical lower basis weight of advanced structured tissue products as the tissue is packaged and delivered a case of product.

Figure 6 shows the cash manufacturing cost per case for conventional wet pressed tissue products in North America and Europe by grade (Commercial and Consumer). North America enjoys a cost advantage over Europe as expected due to lower local energy and fiber costs.

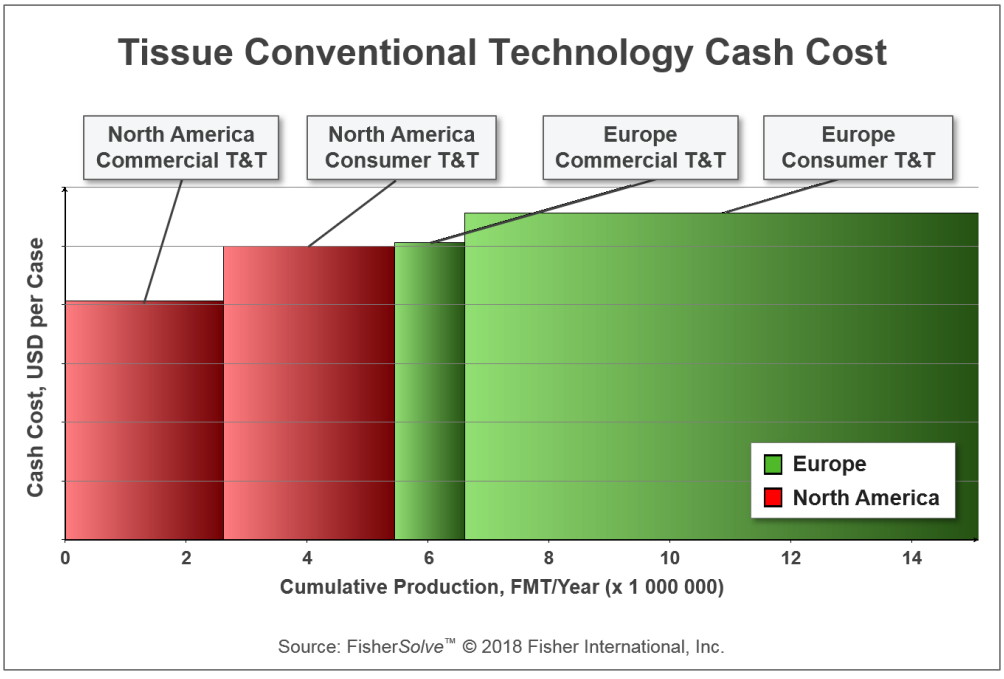

Figure 6

Advanced Technology structured tissue Statistical Case Costs shown in Figure 7 are lower than conventional in the previous chart for all grades in both Europe and North America, indicating an advantage in both costs environments. A casual retail store shelf audit also indicates that the advanced technology tissue products enjoy a higher price, although the preference appears much stronger in North America.

This is probably due to both cultural and product design differences between these markets. This is why we see such a keen focus on advanced tissue technology in spite of the apparent counterintuitive higher energy consumption per ton. Each product format and application is different, and markets are different due to cultural factors. However, the advanced technology must be considered in specific situations and not in blanket averages per ton.

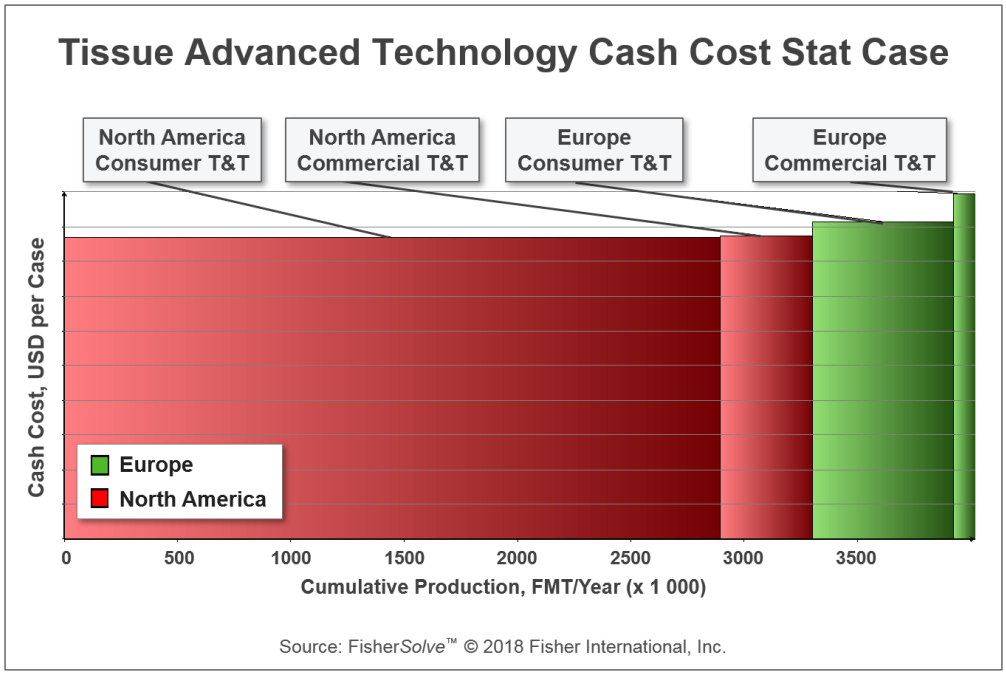

Figure 7

TAD tissue processes always use more energy per ton of tissue produced. They may use less energy per sheet or consumer use depending on the product format and consumer application. The product furnish cost determines the overall economic impact as extra fiber can be used in a conventional dry creped tissue process to improve consumer performance.

Opportunities for Further Study

- This analysis used regional averages for simplicity. Each specific location, equipment design, and product configuration must be considered for best decisions for tissue production. The Fisher*Solve* platform provides a powerful tool for exploring the details for optimal decision making.

- TAD makes up most of the data available for advanced tissue processes. Do ATMOS, eTAD, NTT, or QRT have better energy efficiency than TAD? There is no simple answer as we know from TAD technology that structured tissue products have reduced Yankee dryer contact, reducing overall drying capacity. What is the energy efficiency of the non-TAD advanced structured processes?
- A direct comparison of similar product formats and tissue making technologies energy consumption per ton and case across regions and countries. It is reasonable to assume that regions with lower cost energy may have lower efficiencies than higher cost regions. Can we quantify each area's tissue making energy efficiency?

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[1]Papermaking Part 2, Drying p22. Papermaking Science and Technology 2nd Ed, 2009 Paper Engineers' Association/Paperi ja Puu Oy

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Fisher International, by virtue of its deep expertise in the pulp and paper industry, provides insights, intelligence, benchmarking, and modeling across myriad scenarios. By arming companies with the knowledge that will help them gain a better understanding of their strengths and help identify weaknesses, Fisher is helping businesses stave off challenges and better position themselves for long-term growth.

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