Next generation Advantage™ Thru-Air® technology

Executive Summary

The demand for superior quality tissue is consistently high, especially in the North American and Western European markets. During recent years both private label and branded premium products have required a quality upgrade to meet consumer requirements.

The highest quality tissue and towel products can only be made using TAD technology. The softness and bulk of TAD ultra-bath tissue and the absorbency of TAD premium towel are unsurpassed. TAD technology is also used to produce a wide range of products covering several market segments using furnishes ranging from all virgin to all recycled.

TAD technology became freely available in the late 1990s. It dominated the market for production of premium and ultra-grades of tissue and towel by the mid-2000s. Extensive development led to a new innovative design to meet producer’s needs. This second generation design, the Advantage Thru-Air concept, benefits from reduced capital and energy, increased output, improved product quality, and simplified operation. The ability to meet performance requirements and deliver ultra-quality tissue products explains why tissue makers repeatedly choose the Advantage Thru-Air concept.
Tissue making concepts

Valmet stands on stable technology ground with three tissue making concepts covering the whole product range: conventional, textured and structured tissue.

The Advantage DCT tissue lines (Figure 1, right) are well established within the market today. With 65 installed machines, they produce high quality conventional tissue worldwide. The high efficiency, low energy consumption and high production volumes are appreciated by mills, and repeat orders are more a rule than an exception.

Textured tissue is a fairly new segment, similar to structured tissue but produced on the Advantage NTT machine (Figure 1, left). The machine’s most remarkable feature is its flexibility. In just four hours it is possible to swing from production of textured tissue to conventional or vice versa. This brings unimagined possibilities for product differentiation and to adapt production to changing after-market demand. The first installed machine demonstrated production capacities which exceeded expectations.

TAD technology

The third tissue making concept — structured tissue — refers to the TAD process which delivers a product that is softer and more absorbent than is possible with conventional technology. TAD removes water by vacuum and then by hot air through the sheet, producing a high bulk fully structured sheet. A distinctive pattern is then imparted to the sheet by the TAD Fabric as it passes over a molding box and is then transferred and registered to the Yankee dryer to produce a soft, flexible and bulky product.

The demand for high quality products is increasing in all parts of the world and tissue technology suppliers are constantly aiming to provide equipment producing the best quality for their specific market. In North America and Western Europe consumers value premium or ultra-premium products and the demand for superior quality tissue is consistently high. Recently both private label and branded premium products have required a quality upgrade to fulfill consumers’ requirements.

However, the absolute top ultra-premium products can still only be achieved utilizing the TAD technology. The softness and bulk of its ultra-bath tissue and the absorbency of the premium towel are
unsurpassed. TAD technology spans the entire product range from the finest Ultra-Premium bath to industrial wipes with furnishes from all virgin to all recycled.

Valmet has delivered 25 Advantage Thru-Air machines (Figure 2) since 2000. The second generation Advantage Thru-Air concept was developed to further improve performance and provide ultra-quality tissue to meet consumer demand. Six of these second generation machines are in operation today. Each machine benefits from reduced capital and energy expenditures, increased output, improved product quality and last but not least simplified operations. Previous TAD experience is no longer required to enter the absolute top quality segment.

TAD technology continues to evolve and in the North American market sectors the demand for TAD products continues to grow. The benefits to the producer are the highest possible quality products at outputs from medium to very high. The ability to meet performance requirements and deliver ultra-quality tissue products explains why tissue makers repeatedly choose the Advantage Thru-Air concept.

Meeting the demand

The use of tissue products has become an indispensable part of everyday life for millions of people around the world. No matter where they are used - in the home, at work or in the countryside - consumers enjoy the convenience of tissue and its aesthetic and physical properties. Distinctive appearance, softness, strength, bulk and absorption are all highly valued. Valmet’s Advantage Thru-Air (TAD) Technology provides these desired quality properties and TAD products have now become the preferred choice for consumers in the western world. The Advantage Thru-Air family is appropriate for all production volumes.
Greater bulk and softness with less fiber

Consumer demand has led to an impressive growth in the quantity and variety of Thru-Air Drying (TAD) products on the market. The TAD process delivers a product that is softer and more absorbent than conventional technology allows; characteristics that consumers really value.

An interesting comparison of newsprint and tissue products of about the same basis weight is shown in Figure 3. Of course the cost of producing these products varies enormously, but it does show the potential of TAD towel.

Single or multi-ply products

Advantageous drying rates in the TAD process allow a wide range of basis weights to be produced at high machine speeds. Therefore you can manufacture multi-ply products or reduce the number of plies while increasing your production rate and capital efficiency.

Consumers prefer TAD products

Upgrading of quality is an extremely important driver of tissue demand at a later phase of tissue consumption development. This may be seen at per capita consumption level of some 5-6 kg/person/year, but becomes a very distinctive development factor after 10-11 kg/person/year consumption has been reached (Figure 4).

Multi-ply sheet structure, TAD and advanced fiber technology play key roles in achieving higher tissue quality. The total world TAD tissue consumption (in 1000 tons) from 1990 to 2011 is seen in Figure 5.
Benefits of Advantage Thru-Air technology

Valmet is by far the leading supplier of TAD tissue machines and drying equipment. The knowledge from decades of experience and innovation has been incorporated into our Advantage Thru-Air family to deliver ease of operation, top quality production and flexibility at high output rates.

Reduced expenditure
(Fiber savings – thicker and more absorbent)

Valmet has simplified machine operation and evaluated machine design, building requirements and ancillary equipment in order to minimize project time and capital investment. Moreover, a robust process design and easily manageable machine speeds translate into high machine efficiencies and low operating costs.

Valmet TAD machines are known for their ability to deliver products with superior sheet properties and improved fiber utilization rates than conventional machines. This translates into higher value products with lower fiber costs per case (Figure 6).

Improved product quality and increased output

TAD products deliver the highest rate of absorbency with the lowest basis weight of any comparable tissue product on the market today (Figure 7). Bulk is created in the TAD process at the molding box before the sheet has been fully dried. This bulk is conserved through the remainder of the process since there is no mechanical press dewatering that can compact the sheet. The TAD sheet retains much of its original bulk after it is re-wetted. This gives it its high absorbency and bulk softness.

Simplified operations

In certain cases, established TAD tissue makers want smaller incremental capacity when they enter new geographical markets. In
addition, newcomers to TAD tissue making may find it easier to break into the market by starting out with a machine that produces less tonnage with an overall lower capital cost. To meet this demand Valmet also offers a smaller TAD machine, Thru-Air 100 (Figure 8), a nominal 102" sheet width.

<table>
<thead>
<tr>
<th>Design speed</th>
<th>TAD 100 Family</th>
<th>TAD 135 Family</th>
<th>TAD 200 Family</th>
<th>TAD 300 Family</th>
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<tr>
<td>2000 m/min</td>
<td>TAD 135</td>
<td>TAD 200</td>
<td>TAD 300</td>
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<tr>
<td>1800 m/min</td>
<td>TAD 100</td>
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Figure 8. Advantage Thru-Air program

There is an expansion of TAD capacity in NA mainly driven by retailers seeking to establish their own private label brands. Wal-Mart started this trend and forced the others to follow. The result is a great demand for Ultra-premium products.

We were very pleased that Up and Up towel (sold by Target) made on the first of our Advantage Thru-Air Concept machines took third place in a Consumer Reports January 2012 report, beaten only by two variants of Bounty. What is remarkable is that this was achieved by a company with no TAD experience and within 18 months of start-up. It's a product of machine, process and focused hard work by a dedicated team.

**Advantage Thru-Air process**

The Advantage Thru-Air concept was developed from Valmet's first generation tissue machine. The main focus of the Advantage Thru-Air concept development was to simplify and minimize complexity. Valmet wanted an energy efficient machine that would be easy to operate. After many trials and hours of design work, Advantage Thru-Air machine is what evolved.

With many TAD machines in operation and production, the Advantage Thru-Air tissue machine is truly innovative. It is more compact and operator friendly than earlier designs.

The TAD process (Figure 9) avoids the destructive effect of wet pressing on bulk by instead removing water first by vacuum and then by passing hot air through the sheet. The resulting high bulk fully structured sheet passes through the transfer press via the TAD fabric to produce a soft flexible and bulky product.
The overall machine configuration is comprised of a multi-layer headbox, a roll former, substantial TAD drying section, selective pressing, hoodless Yankee dryer and a belted winding reel.

**Headbox**
The headbox usually has three layers. The multi-layers allows for product layering which is universally used for bath and, increasingly, for towel production.

**Former**
A simple solid roll former (Figure 10) is designed with single sided drainage for trouble-free operation at high speeds. Other features include: advanced mist control, high and medium vacuum dewatering and control system to fine-tune the moisture profile. There are no vacuum or forming roll sleeves to deal with. To cope with high speeds and heavy weights, TAD uses a 72” diameter forming roll for towel and swing machines.

The web is transferred to the inner forming fabric with a vacuum shoe. It is then gently dewatered with a medium vacuum box before turning onto the flat part of the former. Further high vacuum boxes, called molding boxes (Figure 11), build the paper structure and dewater the web to around 22-28% depending on grade before transfer to the TAD fabric. Too little molding doesn’t achieve the full caliper potential and too much makes release tricky at the press roll nip. After the molding process the bulk structure is largely determined. The next phase is to remove more water without compacting the sheet.

**TAD section**
The web enters the TAD section (Figure 12, next page) at about 24-30% dry depending on grade. Bath products tend to dewater better than the more heavily refined towel products. Both basis weight and furnish influence dryness. Valmet uses two large TADs to give a long drying area. This is important both
Advantage Thru-Air technology

for capacity and long fabric life. The long dwell time allows for substantial energy savings as less power is needed than if a single TAD were used.

Most TAD rolls are twelve or sixteen feet in diameter (Figure 13). Many machines have a two by sixteen foot TAD configuration. For wide machines, a double ended exhaust is used to reduce pressure drop and save energy.

Two independent air systems are used within the TAD section (Figure 14). The heart of this process is the Honeycomb roll that has been used to produce tissue for nearly 50 years. This process allows for airflow and temperature to be controlled for each TAD. The first TAD generally has the higher temperature as the wet web protects the fabric from overheating. The natural gas burners are designed to achieve the lowest emissions possible.

**Yankee section**

The use of a hoodless Yankee (Figure 15, next page) greatly simplifies operations. Coating is easier to control and bringing the web over at startup is easier. The fire risk is greatly reduced due to no hot air stream. Also the potential odor of the towel product that can be a result of high hood temperature and impingement speeds is eliminated. Using a

Figure 12. The Thru-Air TAD section uses two large TADs for a long drying area.

Figure 13. Thru-Air TAD rolls on wide machines use a double ended exhaust to reduce energy.

Figure 14. The Thru-Air air system produces the lowest possible emissions, with independent airflow and temperature control.
hoodless Yankee eliminates equipment parts; reducing capital cost, installation cost, maintenance costs and replacement costs.

**Dry end section**

The dry end (Figure 16) comes after the Yankee. The dry end is enclosed to reduce dust levels. A system of foils conveys the web to the belted reel. The SoftReel B belted reel greatly simplifies web handling and eliminates the nip bubble seen on conventional reels.

The SoftReel B (Figure 17) creates a more even wind with reduced caliper variation throughout the roll. (Advantage SoftReel belt reeling is described in detail in a separate white paper entitled "Advanced belt winding for tissue.")

The web is held on the belt by a system of blow boxes. With the reduced nip pressure, bulk is preserved. Then the web is conveyed to the reel nip where a dual nozzle high pressure servo controlled water jet beam is used to provide precise turnovers and eliminate loose paper.

**Summary**

Advantage Thru-Air technology is a success! With the continued demand for ultra-quality in North America, retailers continue to establish and expand their own Ultra quality brands. Newcomers can jump to the top of the market without long learning curves or experience. As technology continues to develop, speeds will also increase. What's next?

*This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.*

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*We are committed to moving our customers' performance forward.*