THEN-AIRFLOW® technology – a story of success

by Roland Adrion, Then Maschinen GmbH, Schwäbisch Hall.

Over the years, what began in 1979 with an ingenious idea has developed into the most environmentally friendly technology in the dyehouse sector of the textile finishing industry. Today, THEN AIRFLOW technology provides results, which a few years ago would have been unthinkable. Moreover, using the latest models, previously unattained economic and ecological advantages are available.

For centuries, large quantities of water, which is a precious human resource, have been used for the dyeing of textiles. Against this background, the THEN development department set itself the task of reducing both the enormous volumes of water needed for piece dyeing together and the related energy costs.

The idea

Rethinking began in 1979, when THEN developed AIRFLOW® technology. Up to this point in time, increasingly expensive water, which was not available everywhere in sufficient quantities, served as the transport medium.

In the 1970s, a winch-dyeing machine required a massive volume of around 150l for the dyeing of 1kg of fabric. In addition, this water had to be heated. It was in view of these statistics that Wilhelm Christ, the head of the THEN R&D department tackled the question of how the enormous water consumption needed for piece dyeing could be cut along with the accompanying energy costs.

This was impossible with the traditional machines used previously, as they employed a bath and even with a jet, water remained the transport medium and therefore consumption was high. Therefore, in 1979 work started on the development of AIRFLOW® technology in co-operation with Hoechst AG, Germany. As Wilhelm Christ recollects, "The starting point was the "Rapidcolor" process for isothermal dyeing. This was used primarily for yarns in a creel system and we upgraded the system our development, which meant that following heating in a steam flow, the separately heated treatment bath was conducted into the jet nozzle for fabric transport and was thus kept in circulation."

Table I: Time comparison between conventional treatment and THEN-AIRFLOW SYNERGY®

Process	Light conventional [min.]	Light SYNERGY [min.]	% ±	Dark conventional [min.]	Dark SYNERGY [min.]	% ±
Pre-bleaching	80	50	37	60	45	25
Rinsing	40	20	50	40	20	50
Dyeing	155	85	45	180	110	38
Rinsing	60	30	50	90	45	50
Total time	335	185	44	370	220	40

Table II: Comparison between conventional and THEN-AIRFLOW SYNERGY® consumption.

Medium	Units	Conventional	THEN - AIRFLOW SYNERGY®
Water	[l/kg]	58 - 86	24 - 42
Steam	[kg/kg]	3.35 – 6.35	1.85 – 2.90
Power	[kWh/kg]	0.20 – 0.38	0.22 – 0.29

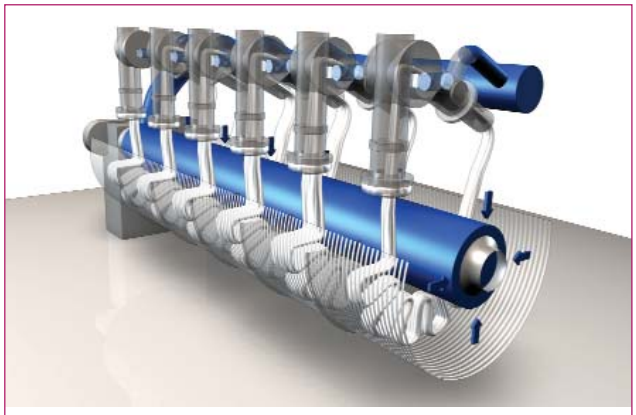

Fig. 1 Air is the key element in patented AIRFLOW® technology as it represents the ideal medium for the transport of piece goods in jet dyeing machines. As a result of the low liquor content in the dyeing autoclave, the goods are lighter than in a conventional machine and can therefore be more quickly accelerated to high speeds.

The initial success – the patent

The next task was to distribute the reduced quantities of dyestuff and additives across the fabric evenly, which could only be achieved by an aerosol. The aerosol replaced the treatment bath and resulted in a completely changed mass ratio. The development work now advanced at speed and in 1981, the fundamental AIRFLOW patent was registered. The inventors were named as:

- Wilhelm Christ, Michelbach
- Dr. Hans-Ulrich von der Eltz, Frankfurt
- Albert Reuther, Frankfurt.

The European patent was registered in1982 and use of the technology commenced simultaneously in numerous countries around the world. A European patent was granted in 1982 and a US patent in 1984.

The AIRFLOW machine made its public debut at the ITMA in Milan in 1983 and was met with general ridicule from the world's experts. Nonetheless, a 10kg capacity machine was installed in the Hoechst AG technology centre and after lengthy customer trials by Hoechst AG and THEN, the market breakthrough was achieved.

Wilhelm Christ, "We launched the first AIRFLOW machine with a 150 kg capacity as early as 1985 and changed the previous design with its parallel use of individual storage chambers, to one involving the simultaneous employment of several chambers in a single autoclave".

The first autoclave-design AIRFLOW machine made its debut at the ITMA in Hanover in 1991 and possessed the basic features of the modern THEN AIRFLOW AFE. If one compares the THEN AIRFLOW AFS from 1991 with the current THEN AIRFLOW, it is evident that targeted optimization of the process technology has resulted in a massive reduction in chemical and water consumption. The most important characteristics of the technology are on the next page:

- Time savings.
- Cost efficiency.
- Reliable dyeing.
- Material protection.
- Reduced ecological impact.

Air, the gentle giant

An airflow constitutes the key element in AIRFLOW® technology, as it represents an ideal transport medium (Fig.1). The replacement of the dye bath by air as the transport medium for piece goods in jet dyeing machines is a patented, pioneering achievement from THEN.

The nozzle pressure is only minimally lower than that in the jet nozzle used to apply the bath liquor, which secures optimum protection of the sensitive surface of the fabric. At the same time, the employment of the mass flow principle ensures greatly improved hank spreading, which prevents creasing.

The moisture-saturated airflow furnishes uniform temperature distribution across the fabric and in the machine, which is a prerequisite for even and reproducible dyeing. As a result of the low liquor content in the dyeing autoclave, the goods are lighter than in a conventional machine and can therefore be more quickly accelerated to high speeds. The risks of draft or yarn strain are minimal, which is of special advantage with regard to the finishing of articles containing elastane.

Everything in one cycle

The fast dyeing process originally known as "High Speed Levelling" (HSL) was brought to serial production maturity in the course of intensive project work. At the beginning of the "One Step Leveller®" process phase, the salt is automatically dissolved in the additives tank (Fig. 2) before being fed into the dyeing autoclave via the injection circuit. The premixed liquor containing dyestuff, chemicals and salt is then evenly applied to the goods fully automatically in a single "all in one" cycle. The dyestuff and chemicals are prepared in a second additive tank, while the salt is retained in the saline solution tank.

This fully automatically controlled and monitored sequence of what is a highly complex procedure at the highest level of process technology, results in a major shortening of the dyeing process in tandem with excellent reproducibility (Table 1). The basic system features also include the second, enlarged additive tank with a direct link to the injection pump. This tank offers sufficient capacity for the entire dye liquor together with the dissolved salt. A tank for the dry salt used in the saline solution is also included in the scope of deliveries.

Enormous time savings

The "THEN - Time Saver®" has an influence on all the process steps downstream of dyeing. Enormous time savings are achieved through the use of the unique THEN-AIRFLOW® "Direct Rinse" method in combination with the "Power Rinse" process (Fig. 3).

Moreover, finely tuned components increase these time savings still further. The most important process features are:

- Via a control circuit with through flow gauge and control valve, "Volmedos" facilitates high-precision dyestuff and chemicals dosing. This means that "Volmedos" immediately fulfils the demands placed on the dyehouse (RFT = right first time).
- The "Dynamizer" process enables rinsing, heating, cooling and dosing in accordance with the fabric length and cycle time in an automatic procedure that adjusts dynamically to the article to be dyed. The "Dynamizer" guarantees the uniform quality of the dyeing process, irrespective of differing batch loads.
- The volume of rinsing water employed per time unit can be programmed and is matched to the need for the rapid washing out of chemicals a hydrolysate. Monitoring takes place using a through flow volume gauge, thus ensuring optimum rinsing on every occasion. An optional hot water tank ensures a sufficient volume of rinsing water and the appropriate rinsing temperature.
- The "Hot Drainer" is the world's only device to allow hot drop at temperatures of over 95°C when the goods are in motion. This is possible during both pre-bleaching and dyeing and offers additional time savings of 15-30 minutes. In the case of polyester articles, hot drop provides the removal of oligomers in a dissolved condition, which means that they do not form a grey deposit on either the goods or the dyeing autoclave.

Fig. 2 At the beginning of the "One Step Leveller®" process phase, the salt is automatically dissolved in the additives tank (below left) before being fed into the dyeing autoclave via the injection circuit. The premixed liquor containing dyestuff, chemicals and salt is then evenly applied to the goods fully automatically in a single "all in one" process cycle. The dyestuff and chemicals are prepared in a second additive tank (yellow).

The result of experience

The new THEN AIRFLOW® SYNERGY represents the result of the interplay between all the technical possibilities and functions offered by current, patented THEN AIRFLOW technology. This furnishes economic and ecological advantages (Table II), which were unobtainable with the dyeing technology used in the past.

The outstanding advantages are:

- Unlimited flexibility for all fibres (except pure wool) and fabrics in a weight range between 30 - 800 g/m, as well as all standard dyestuffs.
- The lowest liquor ratio on the market: synthetic fibres approx. 1:2, natural fibres 1:3 - 1:4, depending on the article and the fabric structure.
- Energy savings of 40% with a frequency inverter. Air as a transport medium instead of the water required by all other machines.
- A reduction in total processing time of around 25%.
- The most advanced piece dyeing machine currently on the market.
- The competitive edge derived from extremely low processing costs.
- Minimum water/wastewater volumes for an ideal, ecological solution.◆