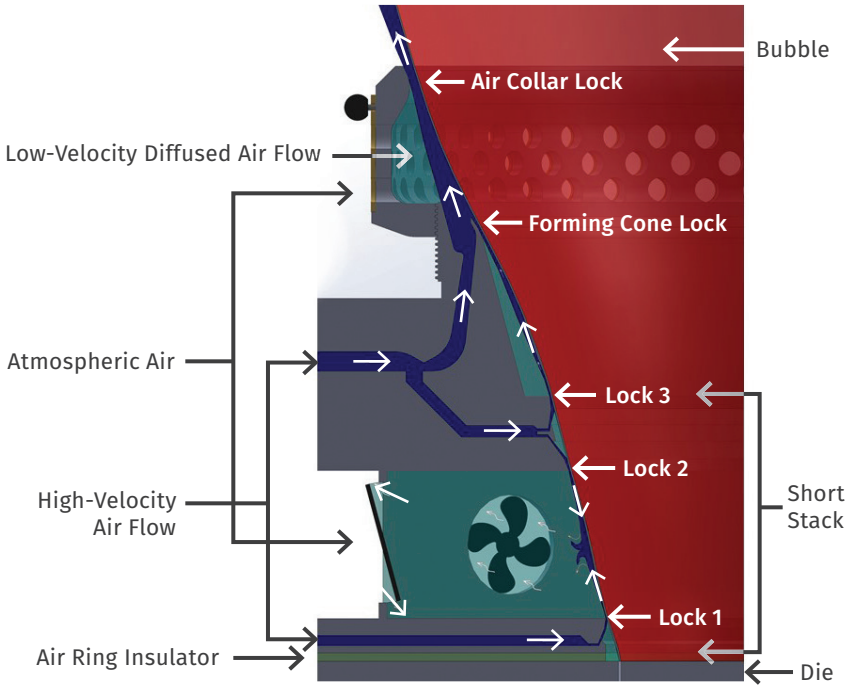
Air Ring Add-On Brings Output to New Level

The Short Stack from Addex sits between the air ring and die and provides high-velocity air flow to boost output and lock in the bubble.

Pancakes aren't the only thing that come in short stacks. Now blown film cooling systems do as well. New film-cooling technology from Addex is said to boost output by more than 25% vs. the company's recently designed Intensive Cooling Down-on-the-Die (DoD) system, which has been shown to bump throughput by 10-15% over conventional designs.

By Jim Callari
Editorial Director

Short Stack Hikes Film Throughput



Addex's Short Stack is sealed to the die above the air ring. The lack of a height-adjustment feature makes it easier to operate. Addex says the device makes possible output gains more than 25%. (Images: Addex)

Addex's Short Stack will be officially unveiled at K 2022, Oct. 19-26 in Düsseldorf, Germany. The Short Stack is positioned directly under the air ring and sits flat on the die. Compared with so-called "raised-up" cooling rings, operators don't have to worry about moving the Short Stack up or down, since its height is not adjustable. This simplifies operation. Says Bob Cree, Addex president, "The height-adjustable systems tend to be tough to start up; the bubble has to be pulled out and around oversized IBC hardware, which is required to push the tube outward into the air ring. Plus, they can be touchy to operate." Cree, who co-invented the device along with Bill Randolph, Addex's R&D manager, says the Short Stack facilitates startup by naturally pulling the bubble into an oversized air ring. The Short Stack can be run with or without conventional IBC hardware.

The Short Stack is fully integrated into the air ring. It uses air from the air ring directly, so no additional blowers or hoses are needed, and it is retrofittable to any blown film line. It removes the traditional lower-lip low-velocity air flow and instead provides three new high-velocity air flows and associated lock points to improve bubble stability. This reportedly allows for higher output rates and easier processing of lower-melt-strength materials.

Addex brought Intensive Cooling technology to blown film at K 2016 with a "blue box" system that featured a series of same-sized stackable cooling elements that were also situated between the die and air ring. This was an extension of film-cooling technology Cree first experienced while working as a group leader in R&D for Mobil in the 1980s. Called the Herrington Stack (after its developer, Jack Herrington), the unit helped Mobil produce "billions of pounds of products," recalls Cree, who worked for Mobil in Macedon, N.Y., for five years as a group leader in R&D before co-founding Addex in 1990.

The earliest application of the Intensive Cooling concept was a purely vertical design with two to four cooling elements. "The 'blue box' was a totally passive system, provided with a vacuum chamber enclosure that held the bubble out," Cree explains. "The bubble stalked

Blown Film's Cooling Gurus Reunite

Some of the blown-film industry's history makers in the area of bubble cooling were in the same place at the same time recently, at Addex's headquarters in Newark, N.Y., for a preview of the Short Stack cooling technology. Joining Addex President Bob Cree and Bill Randolph, R&D manager, were John (Jack) Herrington, retired from Mobil Chemical and inventor of the proprietary high-output Herrington Stack; and Bill Wright, v.p. of technology for film processor Charter NEX and co-inventor of the dual-flow air ring.

Cree and Randolph worked at Mobil Chemical's Research Center in the 1980s, focusing on blown film extrusion. Herrington's stacked cooling concept featured divergent air flows using a large number of small holes aimed in opposite directions, which were used to hold the bubble in place and force it into a fixed imposed shape.

At the time, Herrington was searching for that magical bubble shape that nullifies thickness non-uniformity. His four major patents for Mobil describe imposed-shape cooling. But Herrington's methodology, when driven to very high outputs, created a high degree of turbulent air flow, which created severe bubble vibration and thus "screeching." Herrington and several other researchers through the years attempted to solve the issue, but were never successful.

Bubble cooling icons (l-r): Bill Randolph and Bob Cree of Addex; Jack Herrington, retired from Mobil; and Bill Wright, v.p. of technology for film processor Charter NEX.

Decades later, Cree and Randolph applied a similar divergent air-stream concept to a stackable cooling method, but without the small holes that caused vibration and noise, resulting in the invention of Intensive Cooling. Thirty years later, they returned to Herrington's concept of imposed-shape cooling to readdress the challenge of that magical bubble shape.

Cree says, "In the Short Stack implementation, we have fundamentally achieved what Herrington started back in the 1970s, but now with a high degree of stability and lack of vibration. We also have seen the Short Stack improve gauge variation through bubble shape, so it validates what Herrington described in his patents. And just like Mobil recognized the stacks' capability to generate extremely high output rates, we're doing that as well with the Short Stack, with the added benefit of aerodynamic stabilization of the bubble in multiple locations."

The venerable Wright, meanwhile, studied aerospace engineering and started his career at Boeing. Soon Wright switched industries to blown film, where he began to apply his knowledge of airplane wing aerodynamics to bubble cooling.

This coincided with the LLDPE revolution of the 1970s. Though billed at the time as a drop-in replacement for LDPE, LLDPE did not process as well. As a result, processors were running lines slower and experiencing issues with bubble stability. And single-flow air rings of the day just weren't solving these problems. They had one relatively large exit nozzle that allowed air to impinge directly on the bubble with relatively low velocity, providing a very inefficient rate of heat transfer.

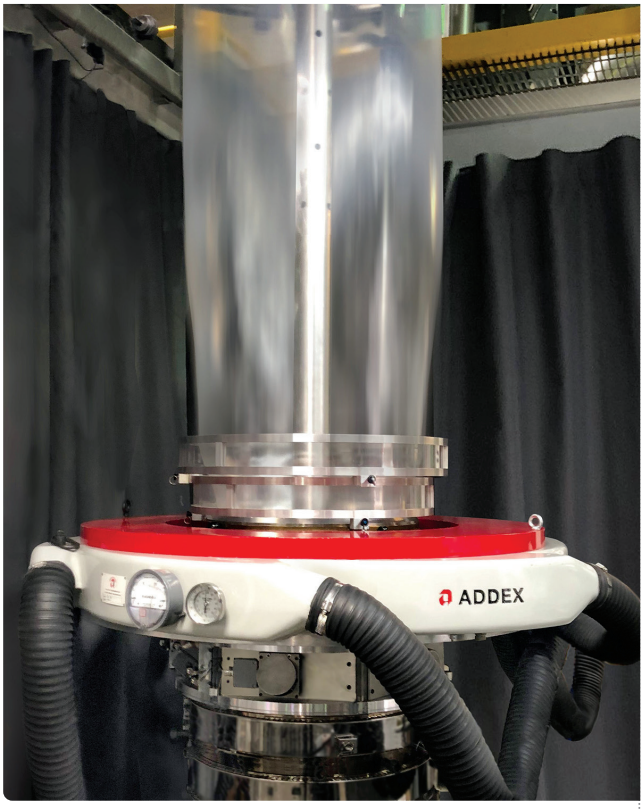
Wright and co-inventors Bob Cole and Mirek Planeta went to work and found that by applying the aerodynamic Coanda effect—the tendency of a fluid jet to stay attached to a convex surface—to redirect air flow alongside the bubble, air velocity would be increased significantly. This acted to strongly pull the bubble out, due to the Venturi effect. The pull-out effect was so strong that it required a second flow of air to create a buffer between the bubble and cooling ring, thus the name dual-flow air ring. Wright went on to found Western Polymer, Planeta founded Macro Engineering and Technology and Cole founded Uni-Flo Systems Inc.

straight up through the system and into the same-size air ring. Bubble stability and output gains were impressive, but soon it was realized that in a real plant environment the system was not particularly operator-friendly—not to mention that with multiple cooling elements, most lines ripe for retrofit could not handle the massive output gains that the system could deliver."

This encouraged Addex to simplify the technology in 2017 with its Down-on-the-Die design, so named because it sat sealed atop the die, similar to a conventional dual-flow air ring. Unlike dual-flow designs, however, the DoD replaced diffused and low-velocity air flow from the lower lip, common in today's dual-flow air rings, with high-velocity air flow. Cree says the DoD proved more operator-friendly than its "blue

box" predecessor as well as other conventional dual-flow air rings. What's more, the high-velocity air stream added an additional stabilization point that locks in the bubble down low, allowing the blowers to be cranked up to increase output.

"Gone are the low-efficiency, low-velocity and very diffused air flows found at the bottom of dual- and triple-lip designs of today," says Cree. Sealing the DoD air ring to the top surface of the die—absolutely no air gap—was another unique feature, he adds, and is important because it means that positive stabilization and high-intensity cooling can begin earlier in the process, literally just above the die lip, allowing hard-to-run films to run at higher speeds. Cree adds, "By adding cooling to the bubble down low, melt strength is immediately increased, which allows air flow to be increased at the main lip, dramatically increasing output rate without sacrificing bubble stability. This is what makes Intensive Cooling fundamentally different from other dual-flow air-ring designs—the aerodynamics are totally unique."



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Says Cree, "The increased stability of the process typically allows companies to use their old extruders up to their maximum capability, which for a majority of the retrofit applications was almost perfectly matched to the 10-15% output gains typical of these DoD systems. As an added bonus, it was soon discovered that this additional new lock point provided what some customers have termed 'incredible' stability that made it possible to run really low-melt-strength materials, which opened up entirely new markets for them, such as for certain barrier applications. In these applications stability is everything and the additional lock point that Intensive Cooling provides gives that capability."

The Short Stack, which is in Beta phase in multiple plants, features three new stabilization points that guarantee bubble stability—two more than DoD, which means few, if any, adjustments are needed, even with material changes. More significantly, it means a less skilled operator can run the line successfully. Addex reports that the Short Stack is proving successful over a broad gamut of processes: larger blowup ratios and thin materials; smaller blowup ratios and thick materials; high-melt-strength and very low-melt-strength materials. Addex guarantees a 20-30% output increase for retrofits. Says Randolph, "It's simple to use and no adjustments are needed over a wide range of processes, including low-melt-strength materials that typically are the bane of raised-up cooling systems, which just can't process these resins."

Cree further explains, "Due to the fundamentally different aerodynamics associated with Intensive Cooling, these systems create entirely new high-velocity lock points for added cooling and bubble stability, and also significantly strengthen the existing lock at the tip of the forming cone. Depending on melt strength, this added stability allows us to put even more air on the process, which yields even more output and stability."

DoD designs are still available. Addex terms that technology an "entry level" into Intensive Cooling, with the Short Stack representing a further step up.

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