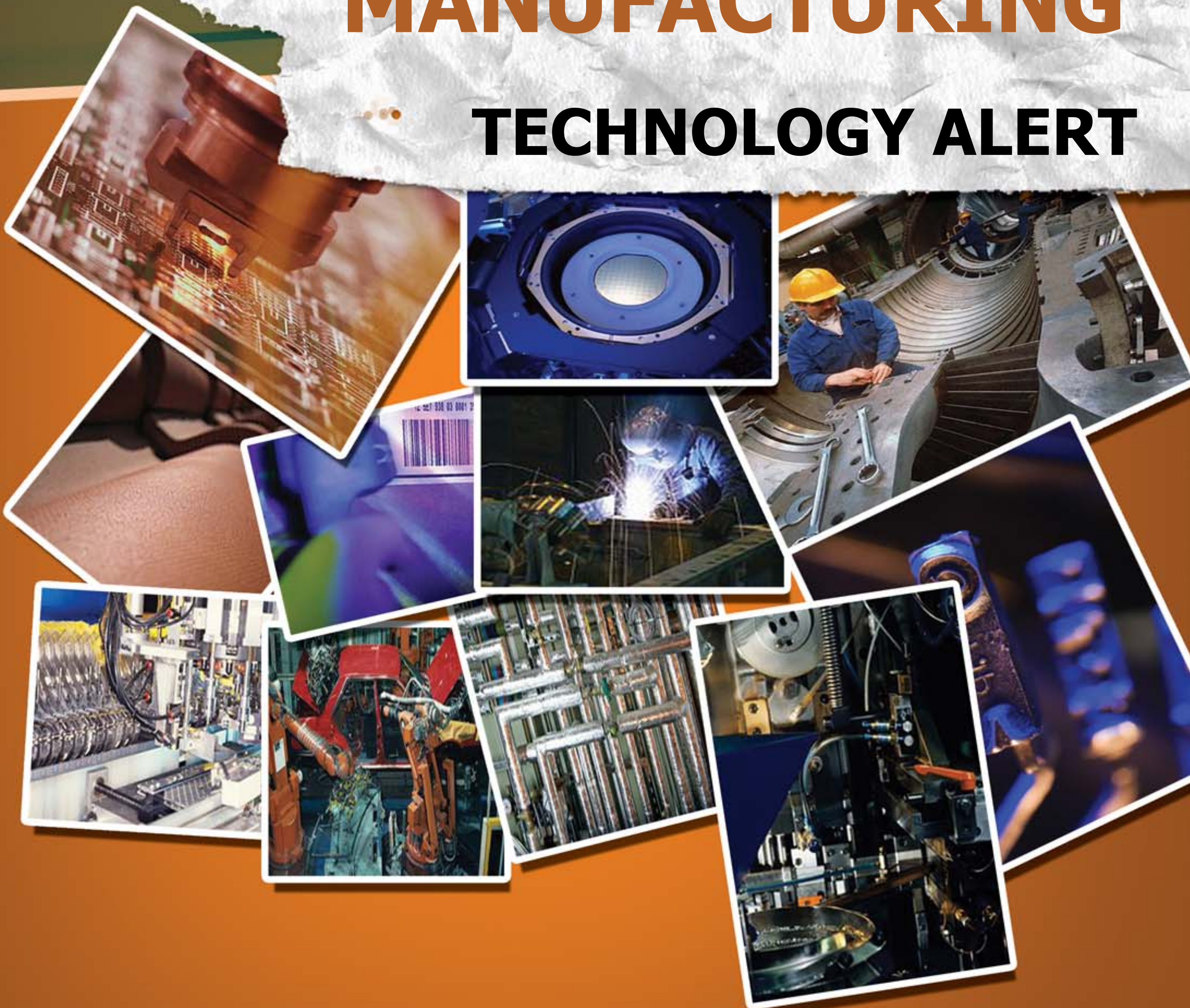
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



12th December 2014

1. MACHINING OF LOW-ALLOY/ULTRA HIGH STRENGTH STEEL

The machining of vacuum-melted low-alloy medium-carbon steels with heat-treated yield strengths at or exceeding 300 ksi (300,000 pounds per square inch), is very demanding. For best results, triple vacuum arc remelt (VAR) ingot melting is specified. The heat treat sequence involves normalizing, heating up, quenching in oil, and then double tempering. This steel family is commonly specified for aircraft landing gear that takes enormous dynamic loads upon landing. Typical steel grades here include AISI 4340M with yield strength of 300 ksi and ultimate tensile strength (UTS) of 339 ksi. The 4340M alloy composition (% of mass) is: 94 Fe, 0.43 C, 0.85 Cr, 0.8 Mn. 0.45 Mo, 1.8 Ni, 1.6 Si). In addition, engineers often specify 300M (silicon and vanadium modified version of 4340M, with yield strength up to 305 ksi). The ductility of both alloy steels is favorable (typically 6% to 8% elongation at failure).

The manufacturing challenge is that this steel (heat-treated) strongly resists cutting (as in turning, drilling, and milling operations), with long, stringy, razor-sharp cuttings spinning off the tool, and is fussy in terms of susceptibility to stress corrosion cracking.

The standard practice is to use cemented tungsten carbide cutting tools, but sometimes cubic boron nitride (CBN) tools are used. Even with such hard tools, machining speeds and feeds for the low-alloy UHS steel work pieces must be moderated to avoid thermal damage (such as de-tempering or ruining the heat treat of the metal). Properly handled and machined, owners will be rewarded with finished steel articles offering excellent strength-to-weight ratio. A related benefit of low-alloy UHS steel is extreme energy absorption before failing (fracturing and separating), useful in the event of an aircraft crash landing.

Special tools are often specified to work with UHS steel landing gear (please refer Exhibit 1). The sophisticated Sandvik boring bar shown (with internal anti-vibration construction) has an 8.66 inch diameter to bore a 12 inch ID hole an impressive 8 ft. deep into a solid forged 300M steel barrel, with a 350 surface feet per minute (sfm) cutting speed. The bored barrel later becomes the female end of a large pneumatic spring mated with a male UHS steel sliding piston; both piston and barrel ID are hard chrome plated.

Exhibit 1 depicts the Sandvik Boring Bar For Low-Alloy UHS Steel (300M) Landing Gear.

Picture Credit: http://www.ctemag.com/aa_pages/2009/0903_Aerospace.html

Details: Larry Rinek, Senior Technology Consultant, Technical Insights, Frost & Sullivan, 331 E. Evelyn Avenue, suite 100, Mountain View, CA 94041, USA. Phone: 650-475-4521. E-mail: lrinek@frost.com. URL: www.ti.frost.com

2. ABRASIVE VERSUS COLD CUT-OFF SAWS

In some manufacturing floor and field repair operations, powerful saws of reasonable size are needed, where a large stationary shop-floor band saw will prove inconvenient. The abrasive cut-off saw (please refer Exhibit 2) is noisy, throws sparks, puts lots of heat into a metal work piece, but is fairly quick and readily handles metal work pieces with high surface hardness (such as heat-treated steels). An abrasive saw typically uses composite friction disc-type blades driven by powerful universal (brush-type) AC motors in portable sizes and AC induction motors for larger wheel sizes. The abrasive cut-off technology has proven to be a good substitute for hazardous acetylene torches for metal cutting applications. The disc diameter could range from 7 inches to 26 inches, with a typical width of 2.8 mm (0.11 inches)

The circular cold saw has a regular tooth pattern (please refer Exhibit 3) with hard teeth doing the cutting, fairly fast. Such cold saws do not add much heat to the metal work pieces, an advantage for preserving mechanical properties. Cold saws are often enhanced with liquid spray or flood coolant at the cutting face. Powerful universal motors (brush-type AC) with rather high power-to-weight ratios are typical for such saws in the portable sizes. Air-cooled universal motors, however, are not as energy efficient (throwing off much waste heat) as brushless AC induction (squirrel cage) motors used for larger cold saws.

Exhibit 2 depicts a DoALL Abrasive Cut-Off Saw, 20" to 22" wheel, 20 hp.
Picture Credit: http://www.industrialmachinery.com/store/index.php?main_page=popup_image_additional&pID=8609&pic=0&products_image_large_additional=images/11796_2.jpg

Exhibit 3 depicts a Makita Cold Cut-Off Saw with Serrated Cutting Teeth (1.75 kW input power).

Picture Credit: http://www.makita.co.za/LC1230.html

Cold cut-off saws are said to slice through common steel tubular work pieces up to four times the speed of abrasive cut-off saws. The re-sharpenable cold saws use either solid high-speed steel (HSS) discs, or cemented tungsten carbide inserts brazed on a vanadium alloy steel carrier disc. Operators need to carefully choose the cutting speed, number of cutting teeth, and feed rates appropriate for the metals being cut. It is common to gear down the motor speed to drive a cutting saw wheel at a constant lower RPM with considerable torque. With cold circular saws, there will be little burring, no sparks and none of the drama exhibited by abrasive cut-off saws. Protective coatings on work pieces are preserved by cold saws. Destructive heat is channeled into the chip cuttings, not the saw or work piece.

Details: Larry Rinek, Senior Technology Consultant, Technical Insights, Frost & Sullivan, 331 E. Evelyn Avenue, suite 100, Mountain View, CA 94041, USA. Phone: 650-475-4521. E-mail: lrinek@frost.com. URL: www.ti.frost.com

3. MACHINING WITH CEMENTED TUNGSTEN CARBIDE TOOLS

The introduction of cemented tungsten carbide (WC) cutting tools in 1927 revolutionized machining, and represented a big step up in performance from high-speed steel (HSS) tools, in terms of speed and feed rates. Turning tools for lathes and milling cutters are popular machining applications for cemented WC. HSS was profiled in a previous Advanced Manufacturing Technology Alert, a few weeks ago. Preformed sintered/cemented WC inserts (please refer Exhibit 4) are widely used today in global machine shops. Tungsten (Swedish for 'heavy stone') is extracted or reduced (metal separated from oxygen) from mined Wolframite ore. This ore is a manganese iron tungstate. The chemical formula is (Mn, Fe) WO_4.

Exhibit 4 depicts Cemented Tungsten Carbide Tool Inserts made in China.
Picture Credit: http://www.tungsten-heavy-metal.com/tungsten-heavy-metal-carbide-insert.html

WC, a gray powder, is synthesized by reacting W metal with carbon at 1400 to 2000 degrees C, a carburizing process. There are various competing processes for joining W with C. Inhalation of fine WC powder is considered toxic to humans. The synthesized WC powder is typically blended with cobalt (Co) metal powder (typically 5% to 10% by mass) and heated in a vacuum chamber to render (via sintering) a solid metal matrix composite (MMC), with WC as the hard phase and Co as the softer supporting phase (matrix). Sometimes, hot isostatic pressing (HIP) is used to consolidate and fully densify the MMC. Vacuum processing is required since WC starts to oxidize and disintegrate in air around 500 to 600 degrees C.

Sometimes nickel (Ni) metal powder is substituted for Co as the sintered metal matrix phase. The finished sintered product is often designated as a cemented carbide. The density, stiffness, and abrasion resistance of this MMC is much higher than steel. However, WC tools are more brittle, so care must be taken to avoid chipping and breakage. The stiffness of the cemented carbide (the Young's modulus) is two times that of steel. The presence of a metal matrix enhances the toughness and durability of the MMC. The sustained sharper edge of WC tools enables a superior surface finish on machined articles.

The extreme hardness of this composite tooling material is such that often only super-hard diamond or cubic boron nitride can cut or grind it. Industrial diamond grinding wheels (with water-spray cooling) can restore the sharp edge to cemented carbide tools. The superior hot hardness of cemented WC allows much higher machining speeds than HSS tools. Symmetrical insert shapes are preferred so that worn edges can be indexed (rotated and/or reversed) in tool holders, quickly providing a fresh cutting face. Cemented WC tools are especially effective for machining steel and stainless steel alloys. Alternative cemented carbide tools are now available for certain uses, such as titanium carbide (TiC), and tantalum carbide (TaC)

Details: Larry Rinek, Senior Technology Consultant, Technical Insights, Frost & Sullivan, 331 E. Evelyn Avenue, suite 100, Mountain View, CA 94041, USA. Phone: 650-475-4521. E-mail: lrinek@frost.com. URL: www.ti.frost.com

4. PATENT ANALYSIS OF BLOW MOLDING

Blow molding is a manufacturing process used to form hollow plastic parts. Blow molding can be classified into three main types; extrusion blow molding, injection blow molding, and injection stretch blow molding. In this process, the plastic is melted and formed into a parison; and in the case of injection and injection stretch blow molding, a preform is formed. The parison is a tube-like piece of plastic with a hole in one end, which allows the compressed air to pass through. The plastic is clamped into the mold and air is blown into it and because of the air pressure, the plastic is pushed out to match the mold. The part is ejected after the plastic has cooled and hardened.

A recent patent in blow molding, US20140302191 A1, assigned to Nissei Asb Machine Co., Ltd., pertains to an injection stretch blow molding device.

Companies are working on various blow molding methods. Examples include FTS Co., Ltd.'s patent for a blow molding device and method capable of forming an article having a built-in part with good yield rate (US20140265052 A1); and Krones AG's patent (US8852492 B2) on a heating device and method for a blow molding machine.

The main applications for blow molding are for production of bottles, jars, and other containers. Examples include Silgan Plastics LLC's patent on a new method and apparatus for forming squeezable plastic containers (US20140021658

A1) and Milacron LLC's patent on a method and apparatus for blow molding and sealing an aseptic container (US7744365 B2).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Blow molding device and blow molding method	Sep 18, 2014 / US20140265052 A1	Fts Co., Ltd.	Takahisa Majima, Toshiaki Asahara, Koji Sugiura	A blow molding device capable of forming a blow molded article having a built-in part with a good yield rate, and a blow molding method. The blow molding device has a blow mold, a parison holding unit and a built-in part holding unit. The parison holding unit has parison expanders and a parison outer holding plate. The built-in part holding unit has an airtight guide tube and a holding rod. After a lower end of a parison is expanded with a plurality of parison expanders, and an upper end of the airtight guide tube is inserted in the lower end of the parison, the lower end of the parison is held between the upper end of the airtight guide tube and the parison outer holding plate, and the preblowing is carried out. After the built-in part is positioned in an interior space of the parison, and the parison and built-in part are held with the slide cores, the holding rod is removed from the blow mold.
Molded article transferring device and blow molding device	Oct 9, 2014 / US20140302191 A1	Nissei Asb Machine Co., Ltd.	Masaki Yamaguchi, Masatoshi Ando, Shuichi Ogihara	In an embodiment, an injection stretch blow molding device includes an injection molding section that produces N (N is an integer equal to or larger 2) preforms by injection molding, a cooling section that subjects the N preforms transferred from the injection molding section to forced cooling, a heating section that continuously transfers and heats the N cooled preforms, and a blow molding section that subjects the N heated preforms to stretch blow molding in n (n is an integer equal to or larger than 2) operations, the blow molding section simultaneously stretch blow molding M (M=N/n, M is a natural number) preforms among the N preforms into M containers.
Heating device and heating method for blow molding machine	Oct 7, 2014 / US8852492 B2	Krones Ag	Wolfgang Schoenberger, Frank Winzinger, Andreas Wutz, Christian Holzer	A heating device and a heating method for a blow molding machine comprise a heating element for radiating heat radiation for heating of preforms. A bottom reflector is movable relative to a counter reflector and is arranged opposite to the heating element for reflection of heat radiation radiated by the heating element in the direction of the preforms. A setting device is used for setting a position (L_A+BM, L_B+BM) of the bottom reflector relative to the counter reflector.
Blow Molding Techniques	Jun 26, 2014 / US20140175710 A1	Boaz Barry Groman	Boaz Barry Groman	In blow mold apparatus, the emergence of a parison from an extruder may be controlled (the parison supported), such as by pulling on the parison or resisting gravity pull to tailor parison wall thickness, overall and locally. The process may proceed discontinuously, such as by stopping extrusion before a parison has achieved its full desired length and continuing pulling. After molding the parison, it may be filled with a material (solid, liquid or gas). A subsequent parison may be molded onto a previously formed parison. Various elements or devices (such as needles, caps, stoppers, valves, plungers) may be incorporated into the part during the molding process.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Blow molding method and apparatus for forming squeezable plastic container	Jan 23, 2014 / US20140021658 A1	Silgan Plastics Llc	Randal D. Porter, Daniel M. Futral, John K. Silva, William J. Peek, Brian J. Benell, Laura A. Flanagan-Kent	A blow-molding method for forming a squeezable or tubular plastic container is provided. The method includes molding a preform having a sidewall, an interior cavity, an open end, a closed end, and a neck adjacent the closed end of the preform. The neck of the preform has an engagement structure. The method includes providing a blow mold system including a blow mold cavity. The method includes placing at least a portion of the preform into the blow mold cavity, and blow molding a one-piece container body from the preform by inflating the preform within the blow mold cavity. The container body has an open end, a closed end and a neck adjacent to the closed end. Wherein the open end of the container body is formed from the open end of the preform, and the closed end of the container body is formed from the closed end of the preform. The method includes creating a dispensing opening through the closed end of the container body.
Blow molding valve for a blow molding valve block	Aug 9, 2012 / US20120201918 A1	Christian Elbs	Christian Elbs	A blow molding valve (400) is provided. The blow molding valve (400) is adapted to be positioned within a blow molding valve block (401) including a control pressure chamber (408), a process gas chamber (450), and a piston bore (413). The blow molding valve (400) includes a control piston (402) movable within the control pressure chamber (408) and a portion of the piston bore (413), the control piston (402) being in fluid communication with a control pressure supply. A diaphragm (405) is provided and positioned between the process gas chamber (450) and the control piston (402) such that the diaphragm provides a fluid tight barrier between the process gas chamber (450) and the control piston (402).
Method for blow-molding a packaging container using a gas and device for implementing same	Oct 16, 2012 / US8287798 B2	Technoplan Engineering S.A.	Daniel Jover, Savino Storione	The invention relates to a method of gas blow forming packaging in a mould using a preform and comprising recovery of the blow gas. The inventive method comprises the following steps consisting in: —) pre-blowing the gas into the preform at a first pressure (P1); —) blowing the gas into the pre-blown packaging at a second pressure (P2) which is greater than the first pressure (P1); —) blowing the gas into the partially-blown packaging at a third pressure (P3) which is greater than the second pressure (P2); —) recovering the gas in a recovery volume until a pre-determined pressure is obtained in the packaging or for a pre-determined period of time; —) using the recovered gas in order to preform pre-blowing operations and the first blowing step; and expanding the air that is free of residual gas in the packaging during and after the recovery phase. The invention also relates to a device that is used to implement said method.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Extrusion blow molding machine and method for the production of a hollow plastic body	Oct 7, 2010 / US20100252964 A1	Kautex Textron Gmbh & Co. Kg	Matthias Franke-Maintz, Klaus Maier, Frank Pritz	The invention relates to an extrusion blow molding machine (**1**) with at least one extrusion head (**2**) and with at least two sheet dies (**3**), arranged next to one another, for the extrusion of sheet-like plastic preforms (**4**), with a multipart molding die (**5**) for processing two preforms into an essentially closed hollow body, having a device for handling the preforms (**4**). The device for handling the preforms comprises at least two grippers (**10**), arranged next to one another on a common carrier (**8**), for receiving the preforms (**4**), the distance between the grippers (**10**) being variable.
Apparatus for blow molding aseptic containers	Jun 29, 2010 / US7744365 B2	Milacron Llc	A. Dale Maddox	An apparatus and method for blow molding and sealing an aseptic container. A pair of mold halves, including inner surfaces that when closed define a mold cavity, clamp about an extruded parison. The parison is inflated by high pressure blow air into conformity with the shape of the mold cavity. An evacuation device applies a force to an exterior portion of the blow molded container causing the portion to deform or flex inwardly, thereby reducing the internal volume and evacuating air from the blow molded container. A sealing tool thereafter causes the blow molded container to be sealed while the container is in the reduced volume condition. Upon removal from the mold assembly and cooling, the container returns to the desired shape.
Synthetic resin double container molded by direct blow molding process	Aug 12, 2010 / US20100200586 A1	Yoshino Kogyosho Co., Ltd.	Mitsuo Furusawa	The technical problems of this invention are to overcome a limitation in the aspect of the shape of conventional synthetic resin double containers comprising an inner container and an outer container and to solve a problem of additional steps required to assemble the outer and inner containers. A principle means taken to solve these problems comprises a double container made by a direct blow molding process wherein a space is formed between the outer layer and the inner layer made of synthetic resins that are mutually non-adherent, thus allowing both layers to be left in a detached state due to a difference in mold shrinkage factors between the two layers during the direct blow molding step.

Exhibit 5 depicts patents related to blow molding.

Picture Credit: Frost & Sullivan

Back to TOC