Latest developments in machinery for gasketing and casting for roller-blades wheels

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Abstract

Cannon started 35 years ago their Polyurethane dosing unit production with low pressure machines performing all traditional technologies where Polyurethanes were involved. Switching in the early '70s to high pressure technology, Cannon have become a leader of this technology, but also went on developing the low pressure series of machines, especially in the direction of low output applications.

In Cannon production range today is possible to find low pressure low output machines for different specific applications. The basic model is the B2 machine, a low pressure metering unit with electronic process control.

These peculiar technologies required specific performances not only related to very low outputs, but also involving new materials which are definitely different from traditional Polyurethanes.

The main special applications where these unit are used for are:

- air filters for automotive industry;
- industrial gaskets;
- slat filling;
- elastomer parts.

This paper focuses on the development of dedicated equipment for gaskets and cast-elastomer wheels.

Picture 1: Typical parts produced with Polyurethane gasketing technology

Gasketing Technology

Cannon Afros have developed the Gasketing technology since 1994. Five years have been a significant period to improve and to set up reliable and cost effective solutions; a team of dedicated people is today working at Cannon to market and assist these proven solutions.

The Gasketing technology is known, from the material point of view, as Foam in Place Material (FIPM) technology. A foam-in-place material is a foam which is applied to a substrate as a liquid or semi-liquid and cures to a solid on the substrate. The technology involves two-component formulations, such as Polyurethane or Silicones. The liquid or semi-liquid material must be applied to the substrate very accurately since curing will occur, and is mostly applied by robots.

Foamed in place products are used as seals or gaskets applied to insulate, dampen out vibration or sound, and prevent the passage or air, particles, or water. Typical formulations used are:

- tixotropic blends for direct gasket application;
- super-soft blends for "in groove" applications;
- solid blends;
- expanded blends.

These functions find application in many industries and with many products. Examples are found in automotive subassemblies, electrical boxes, electrical enclosure doors, appliances, drum lids, industrial filters, light fixtures. *(Picture 1)*

Compared with the traditional manual laying process, where operational mistakes and long cycle times occur, the Polyurethane Gasketing technology provides several advantages such as:

- fast operative cycles (10÷15 seconds for small parts): since these materials are applied by a robot and not manually, their use usually is accompanied by a reduction in labour costs which are often a high fraction of the total cost of a seal or gasket; the overall cost can be reduced dramatically;
- high process automation, saving labour (a single operator controls the whole system);
- increased mechanical and physical properties of gaskets (excellent compression set, reduced permanent deformation, resistance to low temperatures, resistance to aggressive agents, low liquid absorption);
- increased operational qualities (these products can also offer superior performance in that the resulting seal or gasket is continuous; thus, there are no seams which present a possibility for leakage).

This application can replace die-cut gaskets, strip gaskets, moulded gaskets.

We can summarise some advantages given by this technology:

- the materials set and cure at room temperature; this means that the process does not require any additional heat and on top of it all heat-sensitive substances can be used without any problem
- the continuous bead eliminates or minimises the leakage at the connection points of the strip gaskets
- it is a cost-effective alternative to standard gasket materials because all costs for glue in place gasket are eliminated as well as all inventory of various sized gaskets
- the FIPM technology is well proven for several years especially in Europe and USA.

Polyurethanes used for these applications, as well as the technology itself, present some peculiar properties such as:

- high viscosity (some Polyols can reach 50,000 cps and more);
- different ratios (from 1:2 to 1:6 ISO/POL);
- temperature conditioning (very strict operating range);
- air-loading for component nucleation;
- very low output;
- necessity of automated foam dispensing;
- necessity of foamed parts handling.

For these reasons Cannon have developed a complete system composed of three basic parts:

- B2Gplus dedicated metering unit;
- high precision dispensing manipulator;
- different customised handling systems.

The B2Gplus metering unit is a specific development of the basic B2 machine with a special mixing head for micro-shots, with minimal working output lower than 0,5 g/s at an average ratio of 1:4 ISO/POL. *(Picture 2)*

Material temperature conditioning is performed by insulated and jacketed tanks connected with a thermoregulation unit providing hot or cold water, while airloading is guaranteed by a sparger system on the polyol line. In order to precisely dose very low outputs with very high ratio the feeding pump group is mounted close to the tanks group whilst the metering pump group is mounted on the robot arm close to the mixing head; this configuration allows maximum precision and great repeatability.

Picture 2: Cannon b2G, the dedicated machine and head developed for low-output, low-pressure dispensing of formulations for gasketing

The M13 manipulator is a Cartesian robot allowing fast, precise and repeatable dispensing run in groove and on flat surfaces. Working on a typical x/y surface of 1100x2200 mm, it is able to perform a vertical pneumatically-operated z-stroke of 50 mm, on 4 discrete points. With an acceleration of up to 4.5 m/sec^2, this robot reaches a maximum approaching speed of 0.75 m/sec, while during pouring the speed is limited to approx. 0.3 m/sec. The programming software allows for easy and fast recording of the pouring patterns by means of a self-teaching system, and it also takes care of interfacing the operations of the handling system. *(Picture 3)*

Picture 3: Cannon's pouring robot for gasketing

Parts handling means essentially moving items into position, centring and holding while material is dispensed and moving them out of position. A variety of different systems are available according to part size, required productivity, space availability, integration with existing production system. The Cannon standard systems are based on Shuttle table solution (for electrical enclosure doors or appliances parts), where parts are processed onto two different platens, transfer lines (for lamp fixtures and electrical enclosures), special drums (for lamp fixtures), carousels for pallets (automotive parts and small parts in general). *(Picture 4)*

Picture 4: Dedicated handling solutions are available for each application

Cast Elastomer Applications

The other application we are going to analyse is the one related to elastomer Polyurethanes. Standard elastomers generally need to be processed at high temperature. Cannon started developing equipment for this application since a new cold-cure elastomer - which did not require such high temperature - was developed for the production of wheels for in-line skates (roller blade).

The main features of this technology are:

- low temperature casting technology
- high performance rebound
- excellent abrasion resistance
- attractive designs - transparent wheels

The main physical component features at 40°C are the following:

Polyol density	1,12	g/cm^3
Isocyanate density	1,18	g/cm^3
Polyol viscosity	1100	cps
Isocyanate viscosity	470	cps

The main working and process data are:

Ratio POL/ISO	100:81	
Polyol processing temperature	45÷50	°C
Isocyanate processing temp.	35÷40	°C
Mould temperature	55÷60	°C
Cream time	11÷12	s
Free rise density	1,1	g/cm^3
Demoulding time	4÷4,5	min

The final product features are:

Density	1,15÷1,20	g/cm^3
Hardness	82±2	Shore A
Ultimate strength	30	N/mm²
Elongation	530	%
Abrasion (10N 40m)	95	mm^3
Bending fatigue resistance	30.000	cycles

For the production of roller blade wheels with this material Cannon have developed the B2HOT low pressure metering machine. *(Picture 5)* The basic condition was to have the components liquid at room temperature, which means component to be liquid during storage time. The plant is configured as follows:

- pre-heating group for polyol;
- dedicated metering unit;
- pneumatic head holder;
- turning table with relevant moulds.

Picture 5: The special version of dispensing machine used for low-output applications with cast elastomers (skateboard wheels)

At the beginning of the process the component drums are heated up to 40÷45°C in a separate oven and polyol is loaded in a 330 lt. jacketed carbon steel tank tested at 12 bars complete with the following parts:

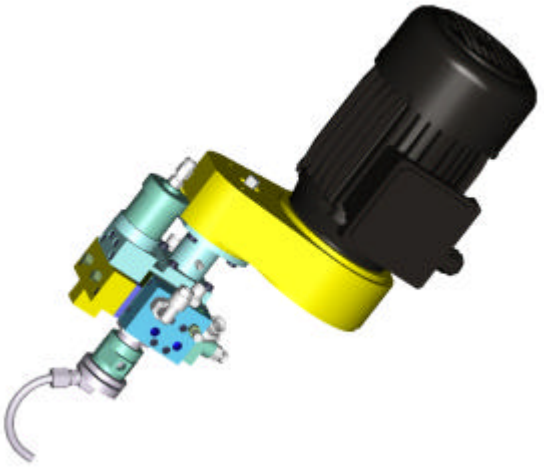
- stirrer
- nitrogen pressurisation system
- vacuum system for component degassing operations. This is of paramount importance because - since the wheels are transparent - no bubbles should be present in the final product. This degassing period can last up to 3÷4 hours, this is the reason why an intermediate polyol storage tank is requested.
- vacuum system for material feeding to the machine tank
- material transfer system to machine tank by means of pressurisation system of the preheating tank
- electrically heated flexible hose from preheating tank to metering unit tank

Both the preheating and the machine tanks are connected to two thermoregulators for temperature conditioning of the component's circuit. After this step the two components are loaded inside the two 70 litres jacketed machine tanks. These tanks are also provided with stirrers, are connected to the vacuum circuit and work with a pressurisation of 0,2 bar approximately. The components temperature must be kept around 50°C. For this reason the complete group (tanks and metering pumps) and rigid piping are positioned into a ventilated box heated through resistances, while the mixing head device flexible hoses are heated electrically.

The material is heated up to the mixing head, but the mixing head itself needs a cooling system in order to prevent any seizing of the mixer which is provided with a cooling jacket. Net or chilled water can be used.

The mixing head is mounted inclined on a two positions pneumatic head holder (in order to allow mixing chamber cleaning) and the nozzle is not straight, but bent to reach the mould on the turning table. *(Picture 6)*

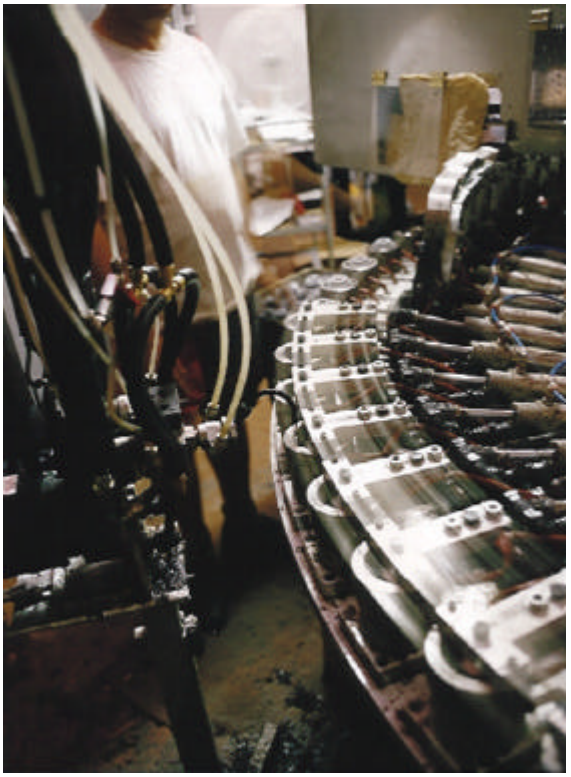
A dedicated turning table - with pneumatically-operated small moulds – is used to produce the wheels: each mould is properly cleaned and fitted with the plastic insert (the hub) . Then it stops for a few seconds in front of the pouring head, that deposits at very low output the required liquid material in the open mould. A curved pipe helps in eliminating dripping problems between pourings. The mould closes immediately after the injection, and the table indexes for the next pouring operation. *(Picture 7)*. After less then five minutes the mould



Picture 6:Cannon special mixing head designed for cast elastomers low-output applications.

opens, and a transparent or coloured wheel is extracted. *(Picture 8)*

Washing operations to clean the mixing head from build-up occur every two hours of production. Up to now eight units are in production on three shifts per day with a cycle time of 5 seconds.



Picture 7:Turning tables with pneumatically-operated moulds are used for the production of these small items

Conclusions

New, exciting opportunities are continuously generated in the field of Polyurethanes by the continuing race between end users (asking for new applications) and chemical suppliers (proposing new formulations). Cannon, leading the Polyurethane-processing field since very many years, contributes to the industrial application of these new opportunities by developing the required processing hardware. Also in the specific field of cast elastomer applications innovative solutions have been introduced by Cannon in the recent years: the development never stops. If you require an industrial solution for a manufacturing problem related with these products, contact the nearest Cannon office.

Picture 8: Skate wheels ready for packing, after a short post-curing session at room temperature

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Biography:

Massimiliano Stolco was born in Varese, Italy, in 1968. He obtained his Degree in Structural Aeronautics Engineering from Politecnico of Milan in 1995. His specialisation is structural and non-structural composite materials. He currently works at Afros, Cannon Division specialising in PUR metering and mixing technology, where he covers the position of Area Manager for Far East Asia and Market Manager Worldwide for Gasketing Applications.