Coolant Filtration in Metal Parts Forming Aluminum Beverage Can Manufacturing

Introduction

Many industries include manufacturing operations that use high-speed presses to form or draw metal products. In high volume operations, where thousands, or even millions, of identical parts are produced daily, even minor variations in manufacturing conditions can cause major problems. This Customer Application Brief (CAB) addresses the manufacturing of an aluminum beverage can body and discusses the benefits obtained by appropriate filtration of the recirculating coolant used in the process.

Effective filtration will:

- maintain coolant quality,
- reduce down time due to increased die life,
- reduce scrap,
- reduce maintenance and associated waste,
- increase plant capacity

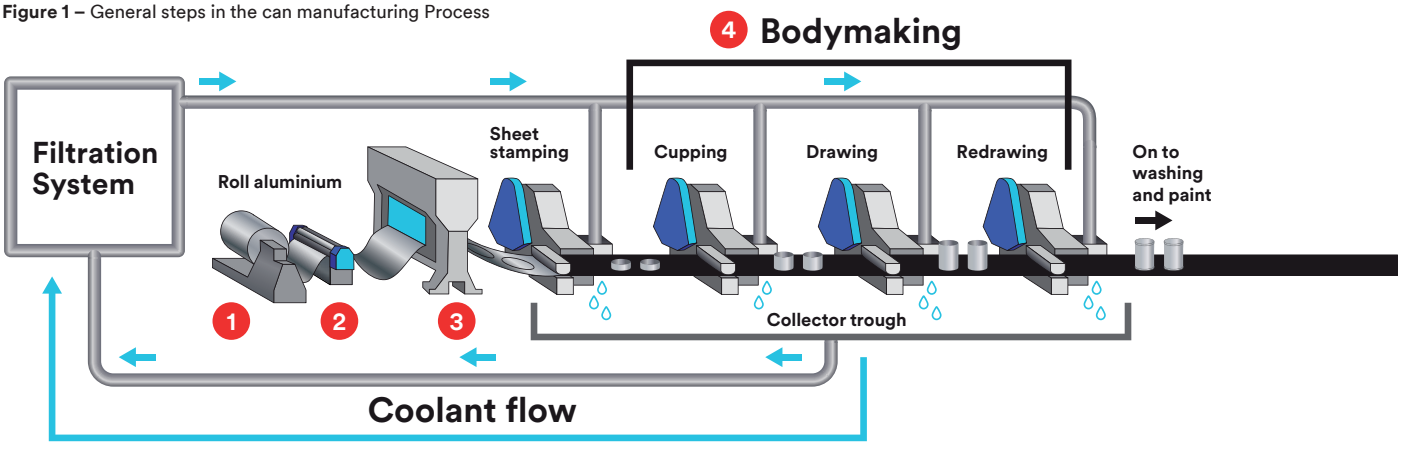
All of which contribute to maximizing the profitability of the aluminum beverage can manufacturing process.

Description of the Application

Aluminum beverage cans are manufactured in two pieces – the body and the closure or cover. The forming of the beverage can body is accomplished through a high-speed drawing process. The aluminum arrives at the plant as coiled stock. Following the numbered sequence in Figure 1, the aluminum stock is unrolled (1), a lubricant is applied to reduce friction between the die and the aluminum (2). The first forming step is “stamping” (3). This converts the flat aluminum to a small cup shape similar in size to that of a tuna can. The cup proceeds on a vacuum conveyor belt to the “body making” equipment where a coolant is applied, to reduce friction and heat that occurs during the drawing process, and the cup is further drawn to the recognizable shape of a beverage can (4). The used coolant is collected, filtered (to eliminate contaminants such as aluminum fines), and then recirculated. The can bodies are processed further, including trimming the top of the can and necking the top to accept the closure, washing, and applying a protective inside coating and decorative outside coating. The can bodies are placed on a pallet, sent to the customer’s plant, filled and closed.

General steps in the can manufacturing process

Figure 1 – General steps in the can manufacturing Process



1 **Aluminium coils** are positioned on the uncoiler. Uncoiler unwinds the aluminium coil into the lubricator.

2 **Lubrication** applies a thin film of lubricant to the aluminium sheet and then feeds the metal onto a cupper.

3 **Stamper** cuts out circular blanks of aluminium and forms the blanks into cups.

4 **Bodymakers** use a punch mounted on a ram to pushthe cups through a series of tooling dies that redraw the cups into cans.

Potential Problems

The operation of the can manufacturing process depends on the filtration in the drawing process to remove contaminant from the coolant. Historically filter presses have been used for this application. The following paragraphs discuss the effect of coolant quality and many of the issues pertaining to the use of filter presses and the related costs.

Coolant Issues

The opportunity to reduce cost and improve quality can be achieved by optimizing the filtration of the coolant system. The purpose of the coolant is to reduce the friction and the resulting heat build-up between the die and the aluminum during the drawing process. During this process, aluminum fines are generated and are carried away with the coolant.

Aluminum fines in the coolant will:

- cause die wear
- die wear will increase can scrap (“tear-offs”)
- increase scrap results in die change

All of which increase the manufacturing costs. Cost savings of a fraction of a cent per 1000 cans are significant when processing 5 to 8 million cans per day.

Process Issues

Many of the current applications utilize a filter press as the primary means of filtration. The filter press is a very expensive capital investment and consists of rolls of filter paper that unwind and “automatically indexes” when the differential pressure (dP) (pressure before the filter paper minus the pressure after the filter paper) reaches a predetermined point. During the indexing stage the coolant is diverted from the press to a by-pass cartridge filter. Once the paper in the press has been cycled the fluid flow is returned to the filter press. Table 1 lists problems experienced with the filter press.

Table 1 – Filter Press Process and Operation Issues

Variable Filtration Efficiency	The filter paper often does not line up properly when indexed into the press resulting in coolant bypass and poor contaminant reduction. Effluent contaminant levels can exceed 200 parts per million (ppm). The filter paper cannot easily be inspected to verify bypass and implement corrective action.
Additional labor required to oversee "automated" process	The filter paper indexing process requires additional service as the paper often does not index properly and the paper must be hand feed through the press.
Costly handling and disposal of spent filter media	The waste filter paper falls into a dumpster requiring additional space, transferring of spent filter paper to disposal drums and increased disposal costs.
Employee Safety Risks	The filter paper media rolls (up to 20) are heavy and awkward to handle. Filter paper media rolls must be lifted 10 feet or more off of the floor and placed on the unwind stands that feed the press. The filter press leaks leaving oil residue in the work area. Significant floor space and housekeeping is required to maintain a clean and safe work environment.

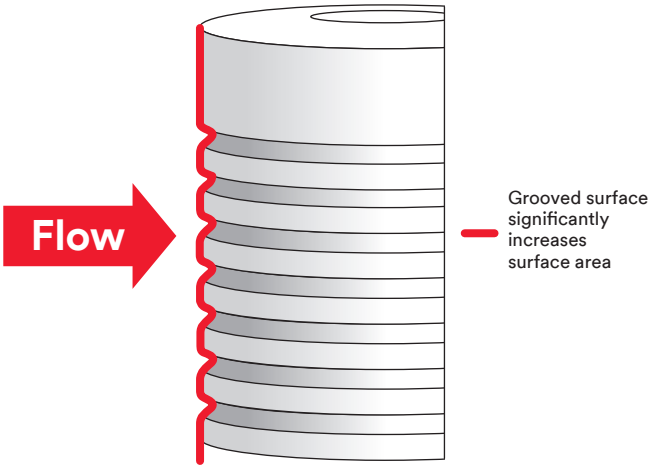
Solution

When considering an economical solution for coolant filtration, 3M offers two proprietary options.

1. Existing Cartridge Housings

The use of 3M™ Micro-Klean™ RT Series Polypropylene Rigid Extrusion Bonded Technology Filter Cartridges as a retrofit product of choice has provided considerable performance advantages for aluminum can manufacturers Vs conventional spun bonded or string wound cartridge options. The unique extruded construction of the Micro-Klean RT Series filter provides a rigid structure depth filter media, which has a grooved outer diameter increasing the surface area by around 62% to maintain a high flow rate and low operational dP that is inexpensive to operate and provides a cleaner coolant fluid.

Figure 2 – Grooved external surface of the 3M™ Micro-Klean™ RT Cartridge



Picture 1 – 3M™ Micro-Klean™ RT Series Filter Cartridge with grooved external surface

The benefits include:

- Low initial clean dP
- High dP operational changeout (up to 2.4 bar)
- Extended cartridge life
- Lower changeout frequencies
- Consistent coolant cleanliness
- Fewer can defects
- Reduced operating costs

When combined with a 3M™ CHB Series filter housing, a premium vessel that provides excellent flexibility in design to meet various flow rates and piping configurations, the user gains significant advantages over the filter press operation (Table 2). For optimum removal of the fine aluminum particles produced during the drawing process, 3M recommends a 5 micron Micro-Klean RT Series cartridge (other grades are available) as shown in Figure 3.

Figure 3 – Recommended Filtration Lubrification System featuring 3M™ Micro-Klean™ RT Filter Cartridge

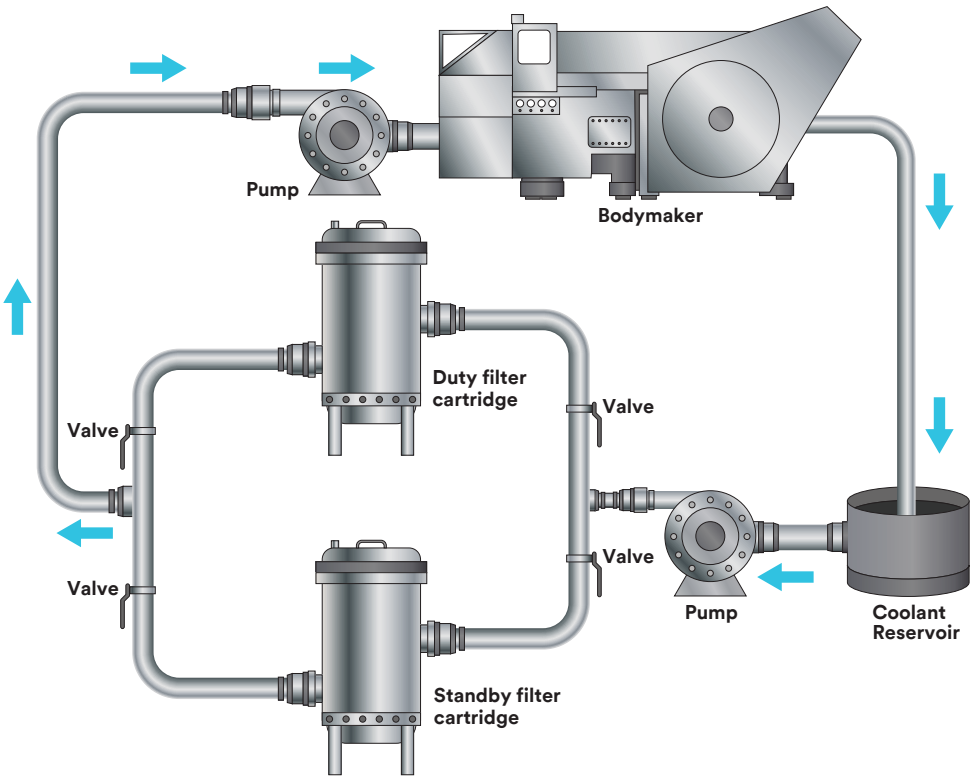


Table 2 – Cartridge Filtration Benefits

Consistent Filtration Efficiency	Cartridges are individually sealed with a spring loaded knife edge seal eliminating the potential for bypass. Effluent contaminant levels well below quality specification. Spent filters can easily be examined during removal from the housing to verify seal integrity.
Simple filter installation without any labor surprises	Individual filter cartridges are easily installed with simple housing bolt closure design.
Ease of handling and disposal of spent filter cartridges	Individual filter cartridges are easily removed and nest nicely in a 55 gallon drum for disposal. Cartridges can be shredded for reduced waste disposal costs.
Employee Safety	The individual filter cartridges weigh less than 1 pound each Installation can be accomplished while standing on the floor. The filter housing is a closed system eliminating coolant leakage and providing a clean work environment. Minimal floor space is required.

2. New Filter Installation

For new or upgrade installations, the 3M™ High Flow HFM Series filter cartridges offer distinct investment and operational advantages for aluminium can manufacturers versus conventional standard cartridge options. The large diameter cartridge design combined with proprietary High Lofted filter media delivers an effective and consistent removal of solids in a compact housing with a small footprint. The result of the cartridge design and filter media is a filter system with a very high surface area to flow ratio, offering low initial clean pressure drops, high solids loading and extended onstream filter life. In addition to the operational benefits, the cartridge has a positive O-ring sealing design to ensure performance integrity and a large ergonomically designed handle to allow easy fitting and removal when replacing the filter. 3M™ High Flow Series housings come in both vertical and horizontal design options to suit the required design criteria.

Picture 2 – SEM picture of 3M™ High Lofted Filter Media

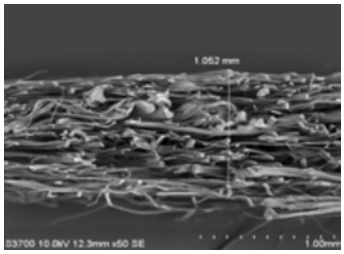
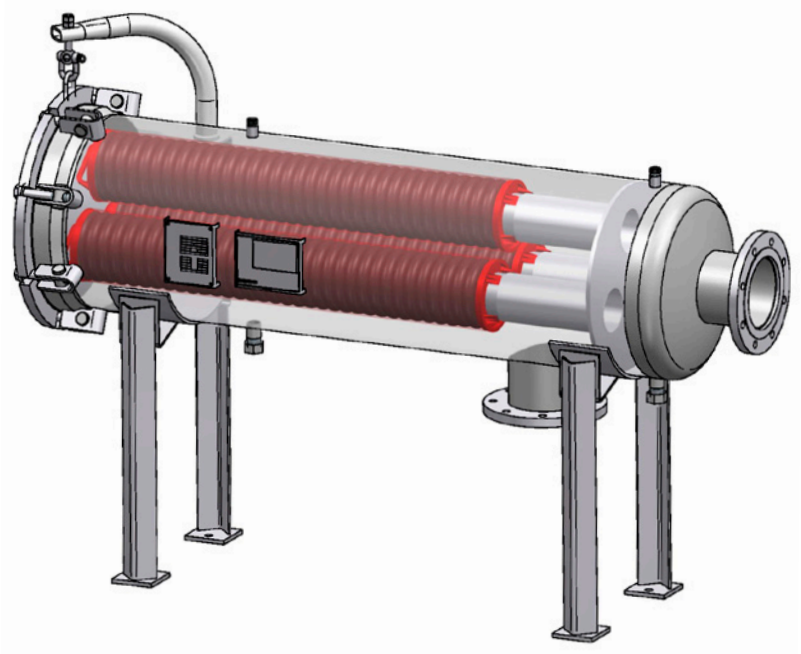


Figure 4 – 3M™ High Flow Series housing in horizontal design



Estimated Savings

Decisions on how a can production facility invests in its future coolant treatment systems needs to be carefully considered.
From Table 3 below it can be seen that to invest in a new filter press system is prohibitively expensive with a high capital outlay.
At a fraction of the cost, to install a filter-based system saves significant capital spend to install the needed hardware, with the optimized savings being made with the large diameter cartridge format offered in 3M™ High Flow design.
Once installed the 3M filter solutions deliver operational cost savings with enhanced and consistent coolant quality which reduces tooling wear, tear off rates, fluid losses and associated disposal costs.
Although in many operational plants today depth type filters (such as 3M™ Micro-Klean™ RT series) are being used which are more economic than the historical filter presses, it is clear that for new plant builds, plant expansions or replacement needs that a large diameter cartridge format system (offered by 3M High Flow series cartridges with the proprietary High Lofted HFM media) delivers the optimized investment and running costs saving some 29K€ per year versus a standard depth filter solution (as shown in the calculations* below) :

Table 3 – Estimated Annual Savings

	Filtration System		
	3M RT	3M HFM	Filter Press
Depreciation Expense – filtration hardware (10 year straight line depreciation)	2.345	1.501	75.040
Annual Media Expense – cartridges vs roll media	54.779	29.875	60.970
Coolant Fluid Losses – disposed of with the cartridges of roll media	657	94	1.970
Disposal Costs – waste drums of cartridges roll media and coolant	4.690	1.876	13.601
Tooling Costs due to poor die life (based on 120€ per die for 20 bodymakers and 20% increase in die life)	6.618	6.618	8.254
Product Scrap (tear-offs) reduction due to improved coolant filtration	5.136	5.136	13.695
Estimated Annual Cost	74.224	45.099	173.530
Annual Savings using HFM vs 3M™ Micro-Klean™ RT series filters		29.125	

* The actual savings will vary from plant to plant, but all the associated costs (both Capital and Operational) should be taken into account when calculating the total cost reduction provided by the 3M filter solution offerings.

Conclusion

Proper coolant filtration will positively impact can manufacturing operations. The elimination of fine aluminum particles in the coolant will reduce die wear, scrap, and, ultimately, decrease operational downtime. For existing installation, 3M™ Micro-Klean™ RT series filters are ideally suited for this application and have demonstrated significant operation and performance advantages, as well as superior economics, when compared to filter presses. For new installation or upgrades we recommend 3M™ High Flow HFM Series filter cartridges combined with 3M™ High Flow housings.

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