Sprue Recycling
Optimize production by saving polycarbonate

Introduction

A recent trend in optical media manufacturing is the escalating price of polycarbonate. Traditionally, sprues – generated as a by-product of disc production – are either simply scrapped or returned to a contractor for re-processing. This is not optimizing the value of sprues, either on a pure cost basis or from a manufacturing logistics standpoint.

The DaTARIUS Group offers a proven solution for effective and efficient recycling of sprues – the Universal Sprue Recycler (USR), which represents a development that spans three years with a proven capability across all formats, including latest generation BD and HD-DVD.

This sprue recycling system allows optical media manufacturers to directly recycle their polycarbonate sprues, thus optimizing their production process. The DaTARIUS USR supports all optical media formats, including pre-recorded and recordable CDs (CD, CD-R, and CD-RW), pre-recorded and recordable DVDs (DVD, DVD±R/RW and DVDR DL), and next generation BD and HD-DVD high-density pre-recorded and recordable media.

The USR provides a uniform and consistent reground granulate size and avoids dust contamination by using the unique patented technology of a moulding machine cycle-synchronous, closed-loop, operation that combines with an optional conveyor system allowing up to three moulding machines to be connected to one USR.

This, combined with lowest cost maintenance leading to low running costs, provides a cost-effective solution with an excellent return on investment. The USR complies with CE and UL safety guidelines and is used by many global optical media manufacturers.

Concept: sprue recycling

Polycarbonate sprues are generated during the moulding process of all optical media.

Traditionally, these sprues are collected and then disposed of at scrap value along with defective or excess discs. Overall this is far from optimized either from a value or manufacturing logistics standpoint.

This is further exacerbated by the rising price of polycarbonate driven by a combination of high oil prices and worldwide demand from other users of optical quality polycarbonate such as the automobile industry. To that end sprues have become a
valuable recyclable by-product for the optical disc manufacturer. Polycarbonate currently accounts for around 60% of total material costs in an optical disc. Of this, as much as 5% can be wasted as non-recycled sprues.

In the case of single layer media such as CD and CD-R, there is a sprue with every disc and, on average (depending upon moulding machine used), a new disc substrate can be made from between 20 and 30 sprues.

In the case of dual layer media, such as DVD and DVDR, each layer produced generates one sprue similar in weight to those originating from a single layer media. Between 10 and 15 sprues (also depending on the moulding machine type) are enough to produce a new half disc.

On a regular production day, with a replication line making 20,000 discs per day, nominally 1,000 discs for single layer media (2,000 discs for dual layer media) can be made from recycling sprues, thus recouping the material’s original value.

**DaTARIUS Sprue Recycler**

With its compact size, proven performance and advanced patented technology, the DaTARIUS USR provides the optical media industry with a reliable solution for optimizing the manufacturing process.

The DaTARIUS USR uses a performance-enhancing and energy-saving cutting mill. Its closed loop operation (directly coupled to the moulding stage) prevents the ingress of impurities (dust, oil, etc), and therefore ensures optimum reground material quality ready for direct recycling. It is compatible with all moulding machines, is simple to install and this, along with its small footprint, allows it to be incorporated within the manufacturing line floor plan.

The critical USR cutting mill components, such as deflector plates, are all constructed from abrasion-resistant aluminium (a new special alloy) with aviation quality stainless steel used for the rotors. The slower drive mechanics, combined with a high torque and unique patented sieve design, ensure a very uniform granulate that can be confidently re-introduced back into the regular material supply.
When fitted with the optional Sprue Conveyor, the DaTARIUS USR can be configured to accept sprues from up to three moulding machines and is adaptable to all moulding machines available today. Two models, Compact and Advanced, provide the manufacturer with solutions to best meet their requirements. The flexibility of the DaTARIUS USR can best be seen by the following illustrations depicting the four standard configurations available.
Media quality: impact of the recycled polycarbonate

Optical parameters:

- **Birefringence:**
  
  An important optical parameter that can have a major impact on the disc quality, birefringence is not influenced by reground material produced by the USR. A common problem that manufacturers face is the ingress of polycarbonate dust. This dust reaches its melt point sooner than the rest of the reground polycarbonate and, as a result, burns and forms carbon particles. These particles – sometimes known as black spots – directly affect the disc quality. One solution used is reducing the barrel temperature in an attempt to reduce the occurrence of black spots. With the DaTARIUS USR, this is NOT necessary as the USR produces a very uniform and consistent granulate size without significant dust production.

- **Dishing (radial and tangential):**

  With its newly developed mixer, the DaTARIUS USR ensures a greater uniformity of the reground material size. By providing a better ratio of virgin polycarbonate to reground material, this helps to eliminate the influence of reground material on thickness deviation and dish density.

Electrical testing (pit forming):

- **Digital errors:**

  Tests have proven that the recycled sprues do not have any impact on the digital errors when using the DaTARIUS USR. These problems are traditionally caused when black spots interact with the pit geometry and affect focusing, thus compromising the integrity of the digital data.

- **HF Signals:**

  The newly developed programmable mixer allows the DaTARIUS USR to control the size of reground material entering the moulding stages. This means that the ratio of reground and virgin polycarbonate can be optimized. This provides a more stable plasticizing time of the extrusion screw on the moulding machine, which means that there is minimum disc weight deviation and no significant erosion in HF signal stability.

Environmental tests:

Extensive tests using the DaTARIUS reference Analyzers have repeatedly proven that after an environmental chamber testing, discs produced with reground sprues do not differ from discs that contain only virgin polycarbonate.
The key to using recycled sprues is the consistency of the milled polycarbonate. This is highlighted by the accompanying picture showing recycled material from the DaTARIUS USR versus inferior technology.

The DaTARIUS USR, with its specially patented sieve design, is able to achieve a consistent granulate size that is critical if disc quality is to be optimized.

**Process Quality**

- **Yield:**

  Extensive field tests and many successful installations at manufacturers producing all formats have proven that the recycled sprues from the USR do not impact on yield either in terms of quality or quantity.

- **Compressed air consumption:**

  The DaTARIUS USR operates a cycle-synchronized system and utilizes pulsed air (synchronized with the robot arm that ejects the sprue) to take the sprues through transfer pipes towards the cutting mill. In this way, energy and compressed air use are kept to a minimum.

  The USR has a 7.75 cfm air consumption. The kW rating of the USR is 0.75 KWh.
Material Savings:

Two examples of DVD and DVD±R manufacturing (based upon real-world data), demonstrate the potential savings to be made with the DaTARIUS USR.

Example 1:
A DVD line with two moulding machines with a single DaTARIUS USR: With a sprue weight of 0.8g and a moulding machine cycle time of three seconds producing 1,200 discs per hour, 24,000 discs would be produced per day. Here a total of 38.40 kg per day are recycled totalling 11,520 kg a year.
Based upon a polycarbonate price of € 3.50 per kg, the annual savings on material equate to € 39,168 a year providing an ROI in two months.

Example 2:
A DVD±R line with two moulding machines and a DaTARIUS USR: With a sprue weight of 0.8g and a moulding machine cycle time of 4.5 seconds producing 800 discs per hour, 16,000 discs would be produced per day. In this case, a total of 25.60 kg per day are recycled, which equates to 7,680 kg per year.
Again, taking a polycarbonate price of € 3.50 per kg, the annual material savings are € 26,112 per year provide an ROI in under six months.

Conclusions: why the DaTARIUS Universal Sprue Recycler?

The DaTARIUS USR provides a proven and tested, cost effective solution for the optimization of polycarbonate use in today’s ever-increasing polycarbonate prices and competitive market place. With a consistent high quality of recycled granulate size, along with lowest energy and maintenance costs and proven unit reliability, it provides the ultimate solution for optimizing polycarbonate recycling.

Return On Investment:

Case studies have proved that the purchase price of the USR can be recouped well within a year of installation. Indeed, on average, the ROI time can be reduced to less than six months (depending upon sprue weight and cycle times).

Key features:

- Slow grind:
  - The slow drive mechanics, combined with a high torque, ensure optimal grinding, while minimizing dust and noise – too high a grind
RPM leads to an increase in dust; conversely, too slow an rpm causes a backlog of material that can lead to blockages.

- **Patented sieve technology:**
  - Specially designed long-life sieves allow only the optimum size and quality of granules to be blended back into the line feed.

- **Closed loop system:**
  - Eliminates contamination of the recycled material and ensures that the sprues remain dry. The USR is designed so that there can be no sprue build-up in the system, which would normally lead to blockages.

- **Special conveyor system:**
  - Allows the connection of up to three moulding machines to one USR utilising a pulsed, compressed air, cycle synchronization system. The stainless steel and aluminium conveyor, replacing traditional rubber belt conveyors, eliminates abrasion and prevents rubber particulates from contaminating the polycarbonate.

- **Low energy consumption:**
  - The USR, with its cycle synchronous pulsing technology and low pressure requirements has low energy consumption, making it extremely efficient to run.

- **Maintenance and installation**
  - The USR requires minimal maintenance and is easy to install. With its compact size, the USR can be easily integrated into the production line. The only routine maintenance required is sieve and knife replacement, which can be achieved quickly, thus avoiding costly downtime and repair bills.

Pictured above
Sprue Recycler with optional Sprue Conveyor
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DaTARIUS Corporate Information
DaTARIUS is a world-leading supplier of test equipment, not only proving the quality of media but helping to improve quality through comprehensive products and services that embrace process optimization.
DaTARIUS produces quality control systems for all formats: pre-recorded, recordable, and rewritable, and its revolutionary DaTABANK™ technology is fully enabled for Blu-ray disc (BD) and HD-DVD testing.
While DaTARIUS test systems come under the general heading of measuring equipment, incorporating Analyzers and Evaluators, the product family extends into two further areas: process optimization, with the MF DisCo temperature optimization system; and inspection, with print label, disc orientation and Ident code validation.
DaTARIUS also offers extensive training through its service centres worldwide. For the last 19 years the company has been at the forefront of this technology and it is fully committed to the future of its customers.
For more information on the company and its products, visit www.DaTARIUS.com

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